THE UNIVERSITY OF ALBERTA

THE DEMAND FOR MEAT AND DAIRY PRODUCTS IN CANADA WITH PROJECTIONS FOR 1980

by

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A THESIS

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ABSTRACT

This study analyzed the Canadian demand for meat and dairy products in relation to other consumer goods and services for the period 1949 to 1969. It also developed conditional expenditure estimates on these products for 1980. The estimates were made in constant 1969 dollars.

Two approaches were used in the calculation of these estimates. Method I involved the use of the linear expenditure system to estimate how consumers will allocate their expenditure income among competing commodities in 1980. The estimated per capita expenditure on food for 1980 was $401.80. Using the estimated expenditure on food and the results of an analysis of the budget proportions devoted to meat and dairy products, the per capita expenditure for 1980 on these commodities was estimated at $148.67 and $60.27 respectively.

Method II used single equation regression analysis on individual commodities to project their 1980 consumption levels. These levels were multiplied by their corresponding 1969 prices to estimate the total expenditure on these commodities. The results for the 1980 per capita expenditure were $146.77 for meat and $60.12 for dairy products.

Using the assumption that the population will reach 25.2 million by 1980, the estimated expenditure on meat is expected to reach 3,748 million dollars using Method I and 3,700 million dollars using Method II. The total expenditure on dairy products in 1980 was estimated as being 1,519 million dollars using Method I and 1,516 million dollars using Method II.

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CHAPTER I

INTRODUCTION

Evolution and Scope of the Study

An analysis of economic activity in the South Saskatchewan River Basin (SSRB) was undertaken with the goal of arriving at a rational policy for investment in the development of water resources in the region (for a description of the SSRB study area see Appendix A). The region relies heavily on agriculture as its economic base, and a large portion of the agricultural production enters the national and international markets. Wheat, feed grain, and livestock production are important agricultural activities in the region. In 1969 the estimated values of these agricultural products for the region were 99.9 million, 70.0 million, and 151.5 million dollars, respectively. Commercial vegetable production, excluding potatoes, was valued at 1.06 million dollars in 1969, constituting 99.8 percent of the value of vegetable production in Alberta.[1]

The relatively low value of vegetable production stems from the small acreage devoted to vegetable crops vis-à-vis other agricultural enterprises. The result is an excess demand situation for vegetables in Alberta, as is the case with Canada. The Canadian farm cash value for vegetables during the period 1968-1970 averaged 92.0 million dollars. At the same time, net imports averaged 79.0 million dollars. However, given the adequate availability of water for irrigation purposes, this region has the potential for intensive production of certain vegetable

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[1]Statistics obtained from Province of Alberta, Department of Agriculture, Edmonton, Alberta.

crops. This could result in the reallocation of agricultural resources in the region.

The water requirements for irrigation purposes are usually high. It has been estimated that some 90 percent of the total water used in the SSRB is devoted to irrigation.[1] Plans for investment in water resources must take into account the high water requirements for irrigation along with the demand for water for other agricultural uses in the region over a long period of time. Water requirements for agricultural uses over a long period can be derived from the long-term demand for agricultural products in the region. The pattern of agricultural development is dictated by intermediate and long-term consumer demands for these products.

Agricultural production constitutes only a part of the economic activity in the SSRB region. The household and industrial sectors are also important elements in determining the long-term demand for water. Because the demand for water is a function of the economic activity of the region, the analysis and projection of economic activity is mandatory.

A modified Leontief input-output model was used in the analyzing and forecasting of economic activity in the SSRB. The input-output approach utilizes (a) the conditional estimation of final demand for each sector of a transactions table describing the intersectoral flow of goods and services within the regional economy and (b) the projection of a new transactions table based on the conditional estimates of final

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[1] G.B. Parlby, Resource Economics Branch, Alberta Department of Agriculture, Personal Communication, Edmonton, Alberta. The same figure was quoted by S.V. Ciriacy-Wantrup of the University of California, Berkeley, in reference to water used for irrigation in California.

demands. In this model the final demands were largely exogenously determined and their determination presented unique problems.

The broad problem confronted in this study was the provision of estimates of consumer demand for specific agricultural products or groups for subsequent inclusion in the final demand vector of the transactions table. Demands for agricultural products arise basically from the demand for food and are highly interrelated. Food, as a group, is highly interrelated with other goods and services competing for consumers' expenditure. Since a large portion of the agricultural products of the region enters the national market, the focus of this inquiry was on the national demand for the products.

A rigorous analysis of the demand for all food categories was necessary. Unfortunately, such an analysis is exceedingly difficult for a single researcher given the existing financial and time constraints. Therefore, this inquiry was directed at the specific problem of analyzing and conditionally estimating the national demand for meat and dairy products for 1980. The usefulness of different methodological approaches in demand analysis and projections were also examined.

Objectives of the Study

The following were the principal objectives of the study:

(1) To describe the trends in food expenditure and consumption in Canada in relation to six other broad categories of goods and services (clothing; housing; transportation and communication; health; recreation, education and entertainment; and miscellaneous goods and services) for the period 1949-1969.

(2) To describe for the same period the consumption and expenditure patterns for meat and dairy products.

(3) To measure and interpret the effects of prices and income on the per capita consumption and expenditure for the seven aggregated categories of goods and services and for meat and dairy products using econometric models.

(4) To utilize the tested econometric models in the projection of the national demand expenditures on meat and dairy products for 1980.

(5) To examine the usefulness of different methodological approaches in demand analysis and projections.

Methodological Approaches

The long-term trends of consumer demand for goods and services are dependent on such factors as amount of disposable income, prices, population, and miscellaneous elements such as tastes and preferences. Level of income is related to the rate of economic productivity and the current government policies on taxation. Prices are a function of both the demand and supply conditions for products and the institutional elements affecting pricing within the marketing system. Population trends depend on the attitudes of the society towards birth rates, the state of the medical arts, and the immigration policies. The factor of time, however, remains constant in all functional relationships of demand.

The patterns of consumption and expenditure related to seven broadly aggregated consumer items and two major classes of foodstuffs were described. Data for the description and subsequent analysis were obtained from the Dominion Bureau of Statistics (now Statistics Canada). Both time-series data and cross-sectional survey data were used for the

period under consideration.

The quantitative analysis and the projections made use of two methodological approaches. Method I used the linear expenditure system developed by Stone.[1] This method has been extended by others enabling it to be used for estimating price, income elasticities, and budget shares for the seven categories (including food as one group) of consumer goods and services. The resulting relationships were used to project national expenditure on food for 1980. Based on the projection of the national demand for food and on an analysis of family food expenditures, the demands for meat and dairy products were projected to 1980. Method II used single equation regression analysis for each commodity in order to project the 1980 consumption levels. These levels were multiplied by their corresponding 1969 price to estimate the total expenditure for each group.

Usefulness of the Study

When using input-output models, the forecasting of economic activity relies upon the technical coefficients relating the sectors and on the conditional estimates of final demand. The analysis and projections of final demands at the national level for the agricultural products in this study should contribute to the estimation of important elements in the final demand vector. Therefore, the conditional estimation of intermediate demands for other agricultural products should be facilitated since they are derived from the final demands.

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[1]R.N. Stone, "Linear Expenditure Systems and Demand Analysis: An Application to the Pattern of British Demand," Economic Journal, 65 (255) (1959), pp. 511-527.

This study should, in its own right, be useful in other ways. It should clarify interrelationships between the demands for agricultural products and other consumer items with respect to expenditure proportions, prices, incomes, and population. The analysis and projection of demand should have important policy implications for producers, marketers, consumers, and governments in the planning and regulating of economic activity. The application and the results of the two methodological approaches should lead researchers in new directions in demand analysis and projection.

CHAPTER II

THE THEORY AND MEASUREMENT OF DEMAND

The theory of demand seeks to explain behavioristic elements in consumers' choices among goods and services in a market economy and to measure the relationships connecting alternative choices. This chapter is intended as a review of the process of selection of alternative goods and services by consumers when constrained by factors affecting their choice. Emphasis is placed on the demand for food items.

The theory of consumer demand is based on the fundamental notions that choice is deliberate and that the chosen set serves to maximise some objective function (i.e., the utility or welfare function). Thus,

$$U = U\ (X_1, X_2, \ldots, X_n) \tag{2.1}$$

where U is an index of utility and X_1, X_2, ..., X_n constitute the choice set of goods and services. Little is known about the exact nature of this function, but it must be at least twice-differentiable if it is to be maximized. Whatever the form of the utility function, the problem remains one of allocating consumer income among the myriad goods and services.[1] How then is consumer income allocated among a variety of goods and services?

Basic Concepts and Definitions

The expenditures that consumers make on a commodity at a

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[1]Saving is regarded as that part of income set aside for future consumption. Since it enters into changes in future expenditures, it is omitted in this analysis.

particular time are dependent on multiple factors. These factors include individual tastes and preferences; the price of the commodity in question; the prices of other goods; and total disposable income which constitutes a budget constraint. The expenditures which the consumers make, or contract to make, relate to a specific time period, as do the quantities of goods and services obtained. The other variables may be operative within or outside that time period.

The Demand Curve

A basic relationship between quantities of goods and services purchased and their prices has been discovered through general observation. Thus, $X_{it} = f\left(\frac{1}{P_{it}} \right)$, which states that consumers usually buy less of a good (X_{it}) when its price (P_{it}) is increased and more when its price is decreased; assuming that income, prices of other goods, and tastes and preferences remain constant. The empirical testing of this inverse relationship yields the familiar downward sloping curve.

Consumers differ with respect to taste and preference, income level, location, and knowledge of prevailing prices. Thus, some individuals will greatly adjust their purchases in response to price changes, while others will not. Or, some will buy relatively large quantities, while others will make few or no purchases, even at very low prices.[1] The above factors remaining constant, the result is a downward sloping demand curve with a characteristic shape, slope, and location for each commodity (Fig. 2a.).

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[1]R.G. Bressler, Jr. and R.A. King, Markets, Prices, and Interregional Trade (New York: John Wiley and Sons, Inc., 1970), p. 53.

The Demand Function

The demand function is defined as being the functional relationship between the quantities of goods purchased and the variables which have been observed to affect those quantities. This function implies a relaxation of the assumption that income, prices of other goods, and tastes are constant, as was used in the definition of the demand curve. Thus,

$$X_{it} = f\ (\ P_{it},\ P_{(n-i)t},\ Y_t,\ T_t\ ),\ i = 1,\ 2,\ \ldots,\ n, \qquad (2.2)$$

where X_{it} is the quantity of good (i) purchased in time, (t), P_{it} is the price of good (i), $P_{(n-i)t}$ are the prices of the other goods, Y_t is the income stream and T_t is an index of tastes and preferences.

In the demand function, the demand curve, being an inverse relationship between the quantity of goods purchased and their prices, is subjected to the modification of its shape, slope, and location due to the influence of changes in the price of other goods, income, tastes, and other related factors (Fig. 2b). All these factors operating simultaneously determine the final demand for a product. The nature of the demand function points out the interrelatedness of the demands for all goods on the market. The closeness of the relationship depends on the uses characteristic of the goods.

Interrelationship Among Demands

The demand concept has as its basis consumers' desire for the goods and services necessary for the sustenance and enjoyment of life. Where these goods and services can be obtained only at a cost, demand relationships are established.

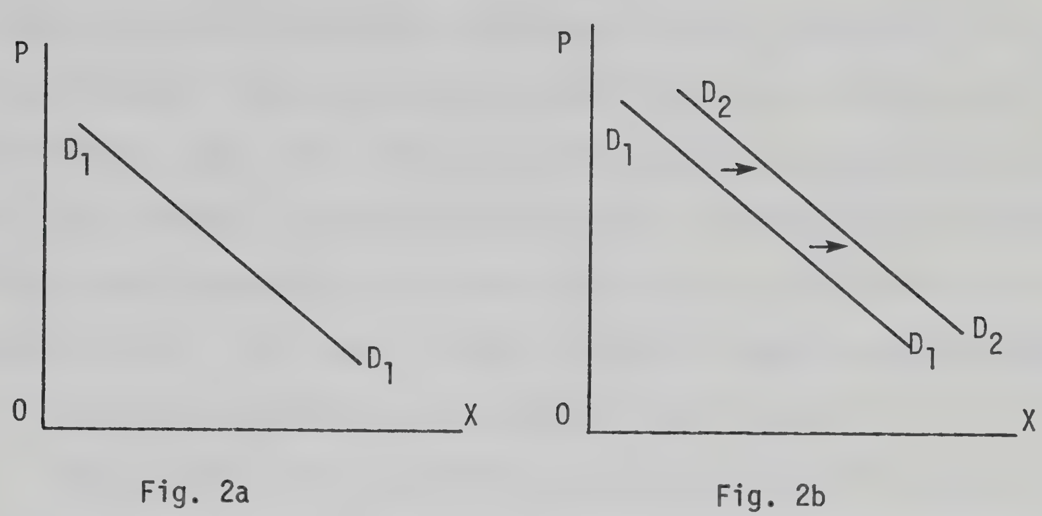

Figure 2.1 THE DEMAND CURVE

Classification of Goods and Services -- The following classifications and comments serve to illustrate the interdependence and interrelatedness among demands for goods and services. Consumers allocate their disposable income among such broad aggregates as: (1) food, (2) clothing, (3) housing, (4) transportation and communication, (5) recreation, education, and entertainment, (6) health, and (7) miscellaneous goods and services. In general, these seven categories compete with each other for a share of the consumers' income. Thus, the percentage of income devoted to food bears some relation to the amount devoted to shelter, clothing, and so on. However, expenditure on health and food may be more closely related because of the biological relationship between food and health. With the food category a further classification might be:

(1) Carbohydrates - sugar and starches

(2) Proteins - meat and milk products, pulses

(3) Lipids - fats and oils

(4) Vitamins - fruits and vegetables, vitamin preparations

(5) Beverages - tea, coffee, alcohol.

Here again, the categories compete for the consumers' food dollar. Depending on income, taste, and price, substitutions such as buying milk instead of meat, may occur. Complementarity exists among and within the groups. For example, a standard meal consists of a combination of several of the above categories, while sugar may constitute an intrinsic part of some beverages. Food items are thus related as substitutes and complements -- important relations in the choice of food items.

The preceding classifications are in keeping with the notions that (a) commodities could be separated into different groups and (b) that consumers follow a two-stage or multi-stage budgeting process. The budget allocation process begins with allocating total expenditures income among several groups of consumer items. This first stage is followed by dividing the budget allocation for each group into different sub-groups. Then, the amount allocated to each sub-group is divided among the individual commodities of that sub-group.[1]

Effect of a Price Change -- When the price of a good drops consumers may buy more of that good and/or other goods, or they may adjust their consumption pattern by substituting other goods for the good whose price has fallen. The first response is designated as the income effect and the latter as the substitution effect. The substitution effect is always positive, but the income effect may be positive or negative. Depending on the influence of the income and substitution effects, the net effect of the price change on the quantity of goods purchased could be

[1] P.S. George and G.A. King, Consumer Demand for Food Commodities in the United States with Projections for 1980, Giannini Foundation Monograph Number 26 (Davis: The University of California, 1971), p. 24.

positive, negative, or neutral. It is thus possible to obtain a decrease in the quantity demanded after a drop in the price of an item as a result of a strong negative income effect (Giffen good case). For example, in the case of falling potato prices, the demand for potatoes may decrease with a concomitant increase in the demand for beef. Other things being equal, the demand for complements move in the same direction.

Elasticity of Demand -- The demand function stipulates a relationship which implies that the demand for a good is responsive to changes in the price of that good, the prices of other goods, income, and other lated variables. This responsiveness of demand to a change in some causal variable is termed the elasticity of demand. Price elasticity of demand is defined as being

$$E_d = \frac{dX_i}{dP_i} \cdot \frac{P_i}{X_i} \ ,$$

where E_d is elasticity of demand with respect to price, dX_i is an infinitesimal change in quantity, X_i is the quantity of good i demanded, and P_i is the price of that good. Similarly, income elasticity of demand is defined as being

$$E_y = \frac{dX_i}{dY} \cdot \frac{Y}{X_i} \ ,$$

where Y refers to income and the other notations are the same as above. A response measuring the degree of substitutability between products is cross elasticity of demand. It is defined as being

$$E_{ij} = \frac{dX_i}{dP_j} \cdot \frac{P_j}{X_j} \ ,$$

where the change in the quantity (X_i) is attributed to a change in the

price of another good (P_j). The larger the elasticity coefficient, the higher the degree of substitutability.

The concept of demand elasticity has been used extensively in demand analysis as a descriptive tool and as a measure of relationships. Another important analytic tool is that of price flexibility, which denotes a responsiveness to a change in the quantity demanded, quantity supplied, or other causal variables.

$$\text{Price Flexibility} = \frac{dP_i}{dX_i} \cdot \frac{X_i}{P_i} \quad .$$

This definition is the reciprocal of the price elasticity of demand. Conceptually, one may have an income price flexibility or a cross price flexibility and so on.

Some Properties of Demand Functions

Demand functions may be derived from utility functions. Manipulation of the utility function shows the derivation of the demand functions and points out the characteristic features which demand functions should satisfy. Assume a twice-differentiable utility function of form

$$U_i = U_2\ (X_i) \qquad i = 1, 2, \ldots, n. \tag{2.3}$$

The problem is one of maximizing this function subject to the budget constraint

$$\sum_{i=1}^{n} P_i X_i + Y \qquad i = 1, 2, \ldots, n, \tag{2.4}$$

where Y refers to total income, P_i is the price of the commodity, and X_i is the quantity demanded of that commodity. The chosen bundle X_i, which provides the individual with the highest possible level on his

preference function, corresponds to the quantities consistent with the maximization of the Lagrangian function

$$U_i = U_i\ (X_i) + \lambda\ (Y - \sum_{i=1}^{n} P_i X_i) \ \ldots \quad . \tag{2.5}$$

The partial derivatives of this function with respect to each X_i and λ yield a set of normal equations which could be solved for the quantities X_i, X_2, ..., X_n and λ, given all corresponding prices and income. The solutions are of the form:

$$X_i = X_i\ (P_1, P_2, \ldots, P_n, Y) \quad i = 1, 2, \ldots, n. \tag{2.6}$$

This familiar demand function relates each commdotiy as a function of its price, the prices of other commodities, and income. Under the maximizing situation the following conditions hold:

$$\frac{dU_1}{dX_1} \ / \ \frac{dU_2}{dX_2} = \frac{P_1}{P_2}\text{, and } \sum_{i=1}^{n} P_i X_i = Y \quad i = 1, 2, \ldots, n.$$

These conditions imply equilibrium conditions even where prices and income change proportionally.[1] This property states that demand functions are homogeneous of degree zero in prices and income. Because of this property, it can be shown that the sum of direct and cross-price elasticities and income elasticities is zero.[2] Also, from the budget constraint, it can be shown that the income elasticities weighted by the corresponding expenditure proportions equals one.[3]

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[1]K. Yoshihara, "Demand Functions: An Application to the Japanese Expenditure Pattern," Econometrica, 37, 2 (1969), pp. 358-259.

[2]P.S. George and G.A. King, op.cit., pp. 9-10.

[3]Ibid.

Total derivative of the Lagrangian function shows the effects of simultaneous changes in the prices and incomes. Thus,

$$\frac{dX_i}{dP_j} + X_j \frac{dX_i}{dY} = \frac{dX_j}{dP_i} + X_i \frac{dX_j}{dY} \quad . \tag{2.7}$$

This symmetric condition of compensated cross-price derivatives is often referred to as the Slutsky condition.[1] Consumers faced with a rising income where prices remain constant might change their expenditure pattern. This situation precludes the possibility of all income elasticities being equal to one. An additional property, therefore, is that:

$$E_y = \frac{dX_i}{dY} \cdot \frac{Y}{X_i} \neq 1 \text{ for all } i.$$[2]

The Two-Stage Maximization Process

Under the assumption of a two-stage budget allocation process, the first stage is to maximize

$$U_i\ (y_1, y_2, \ldots, y_n) - \lambda \left(\sum_{i=1}^{n} y_i - Y \right) \tag{2.8}$$

subject to

$$\sum_{i=1}^{n} y_i = Y \text{ and } \frac{dU_i}{dY_i} - \lambda = 0 \qquad i = 1, 2, \ldots, n,$$

where Y is the total income and y_i is the amount allocated to one of the n groups of commodities. Since the amount allocated to a particular group is also a function of the price index for that group and the price indexes of competing groups, the function could be written in a manner

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[1] Ibid.

[2] K. Yoshihara, op.cit., p. 259.

similar to (2.6). Thus,

$$y_i = y_i \ (P_1, P_2, \ldots, P_n, Y) \quad i = 1, 2, \ldots, n. \tag{2.9}$$

In Equation 2.9 y_i and Y are as previously defined while $P_1, P_2, \ldots, P_n$ are the price indexes for the n groups of commodities. In the second stage, the utility from each sub-group, j, is maximized such that the sum of the amounts allocated to each sub-group equals the amount determined at the first stage; that is, the total expenditure of the group to which the sub-group belongs. Thus,

$$u_j \ (x_1, x_2, \ldots, x_s) - \lambda \ \left(\sum_{j=1}^{s} P_j \ x_j - y_i \right) \tag{2.10}$$

$$i = 1, 2, \ldots, n$$

$$j = 1, 2, \ldots, s$$

must be maximised subject to

$$\sum_{j=1}^{s} p_j \ x_j = y_i \ , \text{ and } \ \frac{dU_j}{dY_i} - \lambda = 0.$$

In Equation 2.10 x_j is the sub-group of commodities, j in group i, p_j is the price index of the sub-group, and y_i is the total budget allocation to group i. Again, the demand function for each sub-group is similar to Equation 2.6. That is,

$$x_j = x_j \ (p_1, p_2, \ldots, p_s, y_i) \ . \tag{2.11}$$

Substituting Equation 2.9 for y_i in equation 2.11 yields the demand function for any commodity as being

$$x_j = x_j \ [p_1, p_2, \ldots, p_s, y_i \ (P_1, P_2, \ldots, P_n, Y)]$$

for all $i = 1, 2, \ldots, n$

$j = 1, 2, \ldots, s.$

The identification of separable groups poses great problems, but the concept of separability certainly reduces the number of parameters to be estimated at any one stage. Also, the interrelationships among demands might be best ascertained with a model which first allocates expenditure among relatively dissimilar groups, then among sub-groups with closer similarities, taking into account the relevant constraints.

The characteristics described above provide a good basis for researchers in the development and application of demand models. It must be recognized, however, that the present state of quantitative analysis, including data limitations, often precludes the rigorous testing of the demand functions encompassing all the theoretical properties. The researcher must, therefore, exercise considerable judgement in the selection, construction, and operation of his model.

Factors Affecting Demand

The preceding demand function highlighted the pertinent variables that influence the demand for goods and services. These variables constitute important data that could be used effectively in demand analysis and projections. This section presents, in greater detail, a description of the influences of these and other factors. The factors influencing the demand for food have been summarized by Ferris as being:

> ... population, age distribution of the population, size of household, per capita incomes, frequency distribution of income, asset position of the consumers, price of the products, prices of substitutes and complements, promotion and merchandising, product innovation, knowledge about nutrition and health,

> occupations, educational levels of consumers, regional influences, religious beliefs, race and nationality, patterns of living, special events, a general category known as 'tastes' and other factors too numerous to mention.[1]

The interrelatedness of the above factors gives leeway for specifying in a model a limited number of the above variables or their proxies without losing analytic precision and predictive power.[2] This section draws heavily from Ferris.

Population

Total demand is a summation of individual demands. The number of people involved in consumption has a determining influence on the final level of consumption and, thus, on demand. In general, a percentage change in the population tends to initiate a similar percentage change in demand, given similar levels and distribution of income. In demand forecasting, an hypothesis about the growth of the population must be made.

The population has certain characteristics which governs its influence on demand. The actual number is only one such characteristic. The age and sex distribution, the size of the grouping (households), the location, and the social customs are all important elements which could be linked with the influence of population on demand. These characteristics change from time to time, thus making not only the actual population change, but making structural changes in its composition.

Population change is governed by the birth rate, the death rate, and the rate of migration. Economic growth conditions have always given

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[1]J.N. Ferris, "Equilibrium and Overall Adjustment," in Agricultural Market Analysis, ed. by V.L. Sorenson (Menasha, Wisconsin: George Banta Company, Inc., 1964), pp. 219-220.

[2]Ibid., p. 220.

impetus to active migration -- the tendency for population to flow from low income to high income areas. Population estimates could be distorted by these factors.

Another aspect of the influence of population on demand is that exerted by the labour force -- the proportion of the population actively employed. This factor is also related to income, since the growth of the labour force is of specific importance to income determination.

Income

The level of income, or income stream, determined by employment opportunities imposes a budget constraint on the demand possibilities. Ernst Engel explored the relationship between income and total food consumption and found that consumers with larger incomes spent more on food, but that it was a smaller percentage of their income. Like the income effect of a price change, the income elasticity of demand could be positive or negative, depending on the product. The implication of Engel's statement is that the demand for food is inelastic with respect to income; that is, less than unity. Though this might be true for food as a group, it is certainly not true for all food products. Further, an increasing proportion of food expenditure is associated with related food services such as processing, merchandising, advertising, promoting, and so on. The result depends on the consumers' choice of services, qualities, and varieties in food.

The budget constraint set by income is not inflexible. The availability of credit tends to slacken the constraint, thus increasing the choice possibilities of consumers. Increasingly less emphasis is placed on current income as the determinant of present consumption. "Fly now,

pay later" and "learn now, pay later" show a change in consumer attitudes with respect to air travel and education. The concept is permeating major sectors of the economy and may play an even greater role in the future as consumers incur debt to satisfy present consumption.

Prices

The prices and cross-elasticities of demand discussed above measure the functional relationship between price and quantities purchased. The price elasticity of a product depends on the availability of substitutes, consumer income and its distribution, proportion of expenditure on the product, the importance of the product, the storability of the product, and the time period under consideration.[1] The price elasticity of demand for food products is generally less than one (inelastic), but greater in the long-run than in the short-run.[2]

Consumer knowledge of price is of great importance to their response. Advertising and promotion provide means of disseminating important information on prices and products. Thus, a fall in price, accompanied by increased promotional efforts, could magnify the elasticity of demand. Such response reflects two elasticities: the price elasticity of demand $\frac{dX_i}{dP_i} \cdot \frac{P_i}{X_i}$ and the elasticity of demand due to promotional efforts $\frac{dX_i}{dA} \cdot \frac{A}{X_i}$ shere dA is the change in level of promotional activities. The response may also reflect the elasticity of demand both

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[1] Ibid., p. 221.

[2] Ibid., p. 222; F.V. Waugh, Demand and Price Analysis, Technical Bulletin 1316 (Washington, D.C.; Economic and Statistical Division, USDA, 1964), p. vi.

for immediate consumption and for storage.[1]

The main determinants of demand have been stated and discussed. An attempt was made to show that each variable did not operate in isolation but that the final demand was dependent on the simultaneous influence of all factors. The impossibility of ascertaining the influence of all factors must be recognized, but should not lead one to give up the problem as being insurmountable. Well-constructed models can account for most of the effects.

While prices do influence demand, the accepted theory is that price is mutually determined by demand and by supply conditions. Some empirical evidence indicates that demands have negligible effects on prices, especially industrial prices, and that most price changes could be accounted for by supply costs.[2] This inevitably leads to supply considerations.

Supply Considerations

Paralleling the analysis of demand, a supply curve and supply function can be specified as

$$Q_{st} = f(P_t) \ ,$$

where the relationship denotes that the quantity supplied, Q_s, in time, t, is a function of the price, P, of the commodity in time, t, other things being equal. And

$$Q_s = f(P_{it}\ P_{(n-i)t},\ C_{nt},\ T) \qquad i = 1, 2, \ldots, n, \qquad (2.12)$$

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[1] J.N. Ferris, op.cit., p. 221.

[2] J.V. Vance, "A Model of Price Flexibility," American Economic Review, 50 (1960), pp. 401-418.

where Q_{st} = quantity supplied in time, t, P_{it} = the price of the product, $P_{(n-i)t}$ = the prices of substitutes and complements in production, C_{nt} = production costs of product, substitutes, and complements, and T = technology.

As with demand, the elasticity of supply may be defined as the responsiveness of a change in quantity supplied, to a change in price or some other causal variable. For example,

$$E_s = \frac{dQ_i}{dP_i} \cdot \frac{P_i}{Q_i} \quad .$$

The elasticity of supply depends on the mobility of resources in the production process, the cost structure of the firms in the industry, the ease of entry and exit of producers, and the time span.[1] The time element is rather important when relating supply to demand and price. Production, which precedes supply and inventory changes, takes time and some production processes require relatively long periods. Production decisions are often made long in advance of the time that the product enters the market. Thus, supply is, to a large extent, a predetermined variable in demand analysis and it gives rise to the problem of lagged adjustment over time.[2]

Input costs and technology are important shifters of supply. Feed grain prices can shift the supply curve to the right or to the left, depending on whether they rise or fall respectively, while technology, which lowers the cost of production, will generate a shift to the right

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[1] J.N. Ferris, op.cit., p. 225.

[2] Ibid., p. 236; J. Purcell, Trends and Relations in the Livestock - Meat Sector Affecting Prices and Revenue to Primary Producers, Research Bulletin 35 (Georgia: The University of Georgia, 1968), p. 10.

in supply. Changes in price of other products may have some effect on the supply of a given product, but a relatively long period usually is necessary for structural changes in production.

The form in which many agricultural products are supplied changes considerably as they move from farmer to consumer. As products flow through the marketing channel, prices reflecting the value added (due to assembly, processing, merchandising, storage, transportation, and distribution) are established, reaching their final level in the retail market. The difference between the price paid for a product at the retail level and the farm price of an equivalent amount of the product is related to the value added as the product moves through the various channels. The difference is called the price spread or market margin[1] and will be taken into account in the discussion of the marketing system.

The Marketing System

The marketing system has been succinctly described by Manchester.[2] The system is comprised of a complex of private and public agencies which impinge upon the marketing process. It includes all the traditional market firms from processor, packager, and wholesaler to retailer and all the public agencies having a relationship with the process of marketing. Also included in the system are the regulatory and service programs of federal and provincial governments. The marketing system connects producers and consumers through a series of markets, thus making available

[1] National Commission on Food Marketing, Price Spread (Washington, D.C.: United States Department of Agriculture, 1968), p. 1.

[2] A.C. Manchester, "Some Thoughts on Agricultural Marketing Research," Agricultural Economics Research 21, No. 2 (1969), p. 29.

to the consumers a variety of goods and services and to the producers information on what to produce.

Marketing Margins and Derived Demands

Farm products undergo changes in form, time, place, and possession utilities as they move from the farm to the final consumer. The addition of utilities is attendant on costs or value added. Two compnents of demand can be discerned: (a) the demand for the product as an item of consumption and (b) the demand for marketing services, including transportation, assembly, processing, grading, merchandising, and such other services as are necessary to transform the farm product into a consumer product. The cost of the final product over and above the cost of an equivalent amount of product at the farm level constitutes the total marketing margin. The demand for the product at the farm level, the demand for factors of production, and the demand for marketing services are derived demands.

The total marketing margin is a summation of the marketing margins of the various firms handling the product. The marketing margin is influenced by the structural characteristics of the market insofar as they affect the pricing of marketing services, the demand and supply conditions, government regulations, and changes in technology.

Price spreads are determined in a number of ways. Two important assumptions regarding their determination are: (a) the percentage markup and (b) the constant dollar mark-up.[1] These two methods have implications for farm level demand elasticity.

The constant percentage spread assumes that the margin is a

[1]P.S. George and G.A. King, op.cit., p. 56.

fixed percentage of the farm level or retail price, regardless of the volume of commodity marketed. With this assumption the elasticity of demand for the product at the farm level is the same as that at the retail level. The implication of this relationship is that the effects of prices change at the retail level are transmitted to the farm level with the same relative magnitude.

The constant dollar spread assumes that the farm level price is increased by a specific amount. Under this assumption, it can be shown that the elasticity of demand for a good at the farm level is the product of the elasticity of that good at the retail level and the ratio of the farm price to the retail price of the good.[1] The result is that the elasticity at the farm level is lower than the elasticity at the retail level. The implication of the result is that farm level demand is less responsive to a change in retail price. Pricing practices in the marketing sector, therefore, contribute to the important role of the marketing system in demand analysis.

Pricing

Because of its important role in demand analysis, some further comments about pricing are relevant. The process of price-making involves deliberate effort on the part of buyers and sellers and depends on their power relations in the market. An excellent classification of pricing systems was drawn up by Rogers[2] and is presented in Table 2.1. The system is particularly relevant to the marketing of agricultural products,

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[1] Ibid., p. 60.

[2] A.B. Rogers, "Pricing Systems and Agricultural Economics Research," Agricultural Economics Research 22, No. 1 (1971), p. 3.

Table 2.1

A GENERAL CLASSIFICATION OF PRICING SYSTEMS[1]

Competitive structure (from less to more competitive in type)	Type of pricing system	Representative method of aids in establishing prices	Some pricing goals and policies[2]
Public monopoly	Authoritarian	Boards, committees, public or quasi-public agencies (announced and/or approved lists). Governmental agreements, negotiation.	Rate of return on investment. Discriminatory (classified). Foreign trade policies. Government price support.
Private monopoly	Authoritarian	Committees, individuals (announced or private lists, or individually quoted).	Profit maximization. Target rate of return. Perpetuation. Discriminatory (differentiation).
Oligopoly	Administered	Committees, individuals, trade associations, agreements among participants, price leadership (announced or private lists, or individually quoted).	Status quo, or change market shares. Predatory price-cutting. Profit maximization. Target rate of return. Sales maximization. Discriminatory (differentiation).
Monopolistic Competition	Administered	Committee, price maker or merchandising manager, trade organization, manufacturer's suggested prices, negotiation.	Customary markups. Variable price merchandising. Meet local competition.
Atomistic	"Automatic" Free, or open market	Terminal markets, country point buying, exchanges, base quotations, auctions, committees, contracts, buyer announcements, negotiation.	Make the best deal you can or take the going market value as established by someone else.

[1]Applies only where facilitating exchange of goods is intended objective. Future markets are thus excluded, although trading results can contribute to cash market price determination.

[2]These represent possible courses of conduct open to firms or group of firms.

Source: A.B. Rogers, "Pricing Systems and Agricultural Economics Research," Agricultural Economics Research 22 No. 1 (1970), p. 3.

as examples could be found which fit into each category; wheat pricing is authoritarian, meat pricing is administered, and cattle pricing is automatic.

The Legal Framework

The development of the private enterprise system was attendant with government intervention in the marketing process and the concomitant enactment of laws. The process of marketing relates buyers and sellers in contractual arrangements. The legal framework sets the rules and limits the conduct of the participants. Many of these rules are sanctioned by the government. The reasons for government intervention are threefold: (1) to maintain freedom and competition since such a system -- the private enterprise system -- is believed to provide the best means for resource allocation; (2) to set up a mechanism for dealing with unfair trade practices which are deemed detrimental to public welfare; and (3) to give assistance to individuals or groups, such as farm groups, whose activities contribute significantly to the general welfare.

The role of the government in the marketing of agricultural products ranges from almost total control, as in the case of wheat, to negligible control, as in the case of beef. The influence of the government and the legal framework can best be assessed by observing some of the legislation.

The Canadian Grain Commission replaced the Board of Grain Commissioners in 1971 under the provisions of the Canada Grain Act of 1970. The Commission seeks to protect the interest of grain producers by establishing and maintaining standards of quality for Canadian grain and to

ensure a dependable commodity for the domestic and export markets.[1] Under the terms of the Canada Grain Act, the Commission is empowered to:

(a) establish grading systems which reflect adequately the quality of the grain and meet the need for efficient marketing of that grain;

(b) establish and apply standards and procedures regulating the handling, transportation, and storage of grain and the management of facilities used therefor;

(c) promote research respecting grain and grain products and advise the minister on such matters relating to grain.[2]

The marketing of agricultural products (except Prairie wheat) under a co-operative plan was provided by the Agricultural Products Co-operative Marketing Act, 1939. The Act helps farmers by guaranteeing minimum initial payment on delivery of their products. The Agricultural Stabilization Act, 1958, authorizes the Agricultural Stabilization Board to even out agricultural price fluctuations, while maintaining a reasonable relationship between farm prices and other prices. The Canadian Dairy Commission, provided for by the Canadian Dairy Commission Act, 1966, is charged with ensuring a continuous and adequate supply of dairy products, while securing a fair return for producers' labour and investment. The Commission sets prices in the interest of producers and consumers.

Aside from the above Acts, provisions have been made through legislation or other means, both at the federal and provincial level, to aid adjustments in marketing and give protection to consumers. The

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[1] The House of Commons of Canada, The Canada Grain Act (Ottawa: Queen's Printer, December, 1970), p. 12.

[2] *Ibid.*, p. 13.

maintenance of a free competitive system is the purpose of the Combines Investigation Act and its subsequent amendments. Under the Act certain practices in restraint of trade are outlawed.

It should be clear that the marketing system is not without government intervention and legal constraints. Government, the legal framework, and the marketing system are dynamic entities. These, together with the dynamic nature of demand and supply conditions, give rise to measurement problems.

Measurement Problems

The foregoing theoretical analysis of consumer demand has set the stage for the measurement and forecasting of demand. The problems consist of (a) setting up models stipulating the variables influencing demand and the direction of influence of these variables; (b) measuring the effects of the independent variables on the dependent variables; (c) computing future values of the independent variables; and (d) estimating the values of the dependent variables from the functional relationships between the dependent and independent variables. Therefore, in demand forecasting, some basic assumptions must be made explicit. These include the effects of the independent variables operative in the future time period being specified and no major dislocation in the economy caused by changes in government policy, war, or depression.[1]

Demand curves may be estimated from sample observations of actual transactions. Consumer surveys relate income and other variables to

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[1] S.N. Kulshrestha, "The Demand for Major Fruits and Vegetables in Canada," Canadian Journal of Agricultural Economics, 18, No. 2 (July, 1970), p. 58.

demand. Time-series analysis provides a means of investigating demand relationships, to which the techniques of regression and correlation analysis have been extensively applied. In demand analysis involving a single commodity, a single equation model may be formulated to estimate income and direct-price elasticities and a limited number of cross-price elasticities of related commodities. Such models have certain limitations in that (a) the researcher must discriminate in his choice of cross-price elasticities to be estimated, and (b) as the number of parameters to be estimated increase, computational problems involving degrees of freedom become evident. Other problems include measurement errors in variables, serial correlation of the errors over time, lagged adjustments, and highly inter-correlated independent variables.

Demand analysis involving the allocation of total expenditures among all goods and services makes use of equation systems incorporating aggregated commodities. The basic unit of such a system is the single equation model, but the single equation model is made to depend on other equations in the system. The problems of identification and estimation are of especial significance in such a system, thus magnifying the problems faced. The crucial measurement problems will be dealt with when analytic techniques are discussed.

CHAPTER III

ANALYTIC TECHNIQUES

A Review of Forecasting Techniques

The researcher uses forecasting techniques to move from knowledge of the past and present conditions to estimates of future states. The forecaster is interested in the future state (at a specific time) of a certain phenomenon conventionally measured on a numerical scale.[1] Several forecasting techniques have been used, ranging from naive procedures to elaborate analytical models. Classification of these techniques poses a problem, but three categories; namely, naive procedures, econometric methods, and input-output models, could encompass most, if not all, of the present techniques used in forecasting.

Naive Procedures

The techniques of this category utilize one or more of the following postulates:[2] (a) the postulate of constancy, implying that the variable whose future value is desired behaves as a constant within the time period evisaged; (b) the postulate of unchanging change, implying that the expected value of the phenomenon will move in the same direction and at the same pace as observed in the past, and (c) the postulate of the periodic variations, which implies that the value of the phenomenon will be subject to fluctuations similar to those observed in the past.

The fitting and extrapolation of straight lines or mathematical

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[1] B. de Jouvenel, The Art of Conjecture (New York: Basic Book Inc., 1967), p. 180.

[2] Ibid., pp. 183-184.

trends are based on the first postulate, while cyclical or harmonic analysis of residuals from trends is based on the third postulate. Fazel[1] summarized rather well trend and harmonic analysis although his system of classification was somewhat different. The distinguishing features of the category are (a) the material used for forecasting consists essentially of past values of the quantity to be predicted, and (b) the method is not based on any explanatory theory and is thus strongly independent of all economic science.[2]

In trend extrapolation, final demand may be treated as a function of time. The relationship is of the form

$$X_i = f\ (T) + e_t \tag{3.1}$$

in which X_i is final demand series, T is the corresponding time series, and e_t a vector of residuals. The resulting time trend is projected to the target time period. The equation adopted may assume simple linearity, linearity in logarithm, a weighted moving average, or any other form deemed acceptable by the researcher.

Where the removal of trend from the time series of final demand reveals a cyclical or quasi-cyclical structure in the resulting residuals, harmonic analysis may be used to simulate the periodicity, intensity and shape characteristics of the cycles and thus to obtain future values of final demand by a simple projection of the cycles. Recently Waugh and Miller applied harmonic analysis to investigate cycles in fish landing

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[1]H. Fazel, "Methods of Revising Input-output Matrix Predications" (Unpublished M.Sc. Thesis, The University of Alberta, 1970), pp. 60-61.

[2]B. de Jouvenel, op.cit.

and prices in the U.S.[1]

Econometric Methods

Econometric models combine diagnosis with predication. Dependency relationships are specified between a dependent variable whose value is to be predicted and one or more independent or explanatory variables. When the expected values of the independent variables are substituted in the models, the expected values of the dependent variables are ascertained.

In the econometric approach use may be made of single equations or a set of simultaneous equations. For example, the single equation technique stipulates that a final demand vector X_t is a function of consumer income Y_t lagged k time units thus,

$$X_t = \emptyset\ (Y_{t-k}, Y_t) + e\ . \tag{3.2}$$

The model may include other variables such as price, tastes, and preference.[2]

A system of consistent simultaneous equations could be built from a set of simple equations as (3.2). Such a system could be effective in forecasting changes in certain sectors or in the economy as a whole. A simultaneous equation model which utilizes the causal chain principle is of the form:

$$X_t = f\ (X_{t-k}, X_{t-2k}, Y_{t-k}, Y_{t-2k}) + e \tag{3.3}$$

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[1] F.V. Waugh and M.M. Miller, "Fish Cycles: A Harmonic Analysis," American Journal of Agricultural Economics, LII, No. 3 (August, 1970), pp. 422-430.

[2] H. Fazel, op.cit.

where X_t denotes final demand, k the lag unit, Y_t an exogenous variable, and e_t the error term.

The system works as follows. The model (3.3) is used to estimate X_t, given the value of the independent variables. The estimate is then used in the model as an independent variable to estimate X_{t+k}. The value of X_{t+k} is then used in the model to estimate X_{t+2k} and so on. This sequential application of estimated values to obtain successive estimates could be useful in the projections of whole vectors of final demands.[1]

Input-Output Forecasting

A set of economic forecasts could be obtained by projecting a transactions table based on the Leontief system of input-output analysis. The transactions table describes the intersectoral flow of goods and services within the economy. Each row in the table shows the distribution of the output of a particular sector among all other sectors and each column shows the inputs purchased by one sector from all other sectors. Technical coefficients are obtained by dividing each of the column entries for a particular industry by the total output of the industry.

The capability of the model to forecast rests heavily on the technical coefficients. In long-term forecasting the constancy of the technical coefficients assumed in input-output analysis is unrealistic and necessitates adjustments for changes in technology. The input-output approach to forecasting (also termed consistent forecasting because the output of each industry is consistent with the intermediate and final

[1] Ibid.

demands for its products) utilizes (a) conditional estimates of final demands for each sector and (b) the projection of a new transactions table based on the conditional estimates of final demand.[1] The input-output approach thus relies initially on other methods for final demand forecasting.

The General Linear Model

The Model

When one expects a certain variable, Y_i ($i = 1, 2, \ldots, n$), to be determined by a set of variables X_i ($j = 1, 2, \ldots, k$), simultaneously, such a relationship may be tested by the application of the general linear model. The model in matrix notation is of the form

$$Y = XB + u \tag{3.4}$$

in which Y is a column vector of observations on the dependent variable, X is an n x k matrix of observations on the independent variables, B is a vector of unknown parameters to be estimated and u is a vector of random errors. The equation specifies that the observable quantities X and the unobservable random errors u represent the causes that determine the values of Y, u accounting for the effects of all unidentifiable factors.[2]

The Assumptions

1. The model assumes linearity in the functional relationship between the dependent variable Y and the independent variables X. It

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[1] W.H. Miernyk, The Elements of Input-output Analysis (New York: Random House, 1967), p. 33.

[2] E. Malinvaud, Statistical Methods of Econometrics (Chicago: Rand McNally and Company, 1966), pp. 73-74.

further assumes that there are no appreciable differences between the observed values of Y and X and their 'true' values.

2. The random error u is distributed normally and independently of the number of observations, the independent variables, and each other; with a mean of zero and a variance. An important implication of this assumption is that there is no correlation between u_t and u_{t+1} where t and t+1 refer to different time periods.

3. The independent variables are a fixed set of numbers with a mean and variance, and no exact linear relationships exists among them.

4. The number of observations must be greater than the number of parameters to be estimated. This assumption ensures the existence of the inverse $(X'X)^{-1}$, which plays a crucial role in the estimation procedure.

Estimation Procedure

The estimation problem is one of deriving estimates for the elements of the B vector of unknown parameters. In keeping with the Gauss-Markov theorem, the method of least squares yields the best linear unbiased estimates of the B coefficients. The estimates are determined by minimizing

e'e - the sum of the squared residuals, with respect to

$\hat{B}$ in the equation

$$Y = X\hat{B} + e \tag{3.5}$$

where $\hat{B}$ is a column vector of B estimates and e is a column vector of residuals (u-u) subject to

E (e) = 0

E (e'e) = $\sigma^2 1_n$, where σ^2 is the variance and 1_n is an identity

matrix

X is a fixed set of numbers

X has rank $k < n$.

Thus $\frac{d(e'e)}{d\hat{B}} = -2X'Y + 2X'X\hat{B}$

which when equated to zero gives

$$\hat{B} = (X'X)^{-1} X'Y \tag{3.6}$$

which is a minimum since $\frac{d^2(e'e)}{d^2\hat{B}}$ is positive when the expression is equated to zero. Also, $\hat{B} = B + (X'X)^{-1} X'U$ since $Y = XB + U$ and $(X'X)^{-1}(X'X)$ is an identity matrix. Using expected values in both sides of equation (3.6) gives $E(\hat{B}) = E(B) + E[(X'X) X'U] = B + (X'X)^{-1} X\ EU$; and since X is a fixed set of numbers and E(U) equals zero by assumption, $E(\hat{B}) = B$, implying unbiased leased squares estimates. Further calculations yield:

1. the variance covariance matrix of the B's as $\text{var}(\hat{B}) = \sigma^2 (X'X)^{-1}$ where σ^2 is the variance of the error term;
2. the unbiased estimator of the variance of the error term as $\hat{S}^2 = e'e / n-k$;
3. the ratio of the explained variance to the total variance as $R^2 = \hat{B}' X'Y/Y'Y$ - the coefficient of multiple correlation.[1]

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[1]J. Johnston, Econometric Methods (New York: McGraw-Hill Book Company, Inc., 1963), pp. 134-135.

Tests of Significance

The t- and F-statistics, respectively, are employed to ascertain whether an element or all elements of the B vector are significantly different from zero. Thus the test that $B_i = 0$, $(i = 1, 2, 3, \ldots, k)$ is based on

$$t = \frac{B_i - \hat{B}_i}{s\sqrt{a_{ii}}}$$

with n - k degrees of freedom and a_{ii} the element corresponding to X_i in the principal diagonal of $(X'X)^{-1}$. The test that $B_2 = \ldots = B_k = 0$ is based on $F = \dfrac{R^2/K - 1}{(1 - R^2) / n\text{-}k}$, where k - 1 and n - k are degrees of freedom. These tests are particularly important in forecasting since they establish the degree of confidence one has in a model and the coefficients.

Evidence of serial correlation can be tested by the Durbin-Watson d-statistic, defined as

$$d = \frac{\sum_{t=2}^{n} (e_t - e_{t+1})^2}{\sum_{t=1}^{n} e_t^2} \tag{3.7}$$

Upper and lower boundaries, du and dl, respectively, of the d-statistic have been tabulated for various values of the number of observations (n) and number of independent variables (k), and those boundaries might be employed in testing for autocorrelative disturbance as follows:

(a) d < dl implies positive autocorrelation

(b) d < du implies negative autocorrelation

(c) dl < d < du is inconclusive.[1]

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[1]Ibid., p. 192.

Discussion on the above model and the estimation procedure shows the heavy reliance of the model on the random errors of residuals and the assumptions regarding them. After the effects of the identifiable causal variables have been ascertained, further analysis of the residuals may lead to improved estimates and model reformulations.

When the test on the residuals leads one to suspect serial correlation, the model may be reformulated as

$Y_t = X_t B + u_t$, in which the u_t follows a first-order autoregresive scheme

$u_t = \rho\, u_{t-1} + e_t$ where $|\rho| < 1$ and e_t satisfies the assumption

$$E\,(e_t) = 0$$

$$E\,(e_t e_{t+s}) = \begin{cases} \sigma_e^2 & s = 0 \\ 0 & s \neq 0 \end{cases} \quad \text{for all } t.$$

The estimation of final B values follows a series of steps. A preliminary set of B coefficients are found by first calculating u_t by ordinary least squares. The resulting residuals are subjected to a similar procedure according to the specific autoregressive scheme to ascertain the value of ρ. Finally the transformed Y variables are regressed on the transformed X variables.[1] When the value of ρ approaches 1, the model might be formulated as first differences thus,

$$(Y_t - Y_{t-1}) = (X_t - X_{t-1})\, B + u, \tag{3.8}$$

and the B estimates found by direct least squares.

When the trend of the residuals over time can be divided into

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[1] *Ibid.*, pp. 178, 194, 196.

mutually exclusive classes or groups, the incorporation of dummy variables in the regression model can measure significant intercept difference and thus change the final values of estimates.

Multirelational Models

The focus so far has been on single equation models, their estimation by ordinary least squares, and some extensions involving error terms. The interdependence of economic relations gives good reason for specification of models involving several relations, thus constituting an interdependent system. These relations, like single equation models, consist of endogenous (dependent) and exogenous (explanatory) variables, but the endogenous variables in interdependent systems are determined simultaneously by all the relations in the system.

Structural Form vs Reduced Form

Each equation is typified as a structural form or a reduced form. The structural form of a stochastic interdependent system can be written:

$Y = B\ Y + \Gamma Z + \delta$ and the reduced form as $Y = \Omega\ Z + e$

where $\Omega = (1 - B)^{-1}\ \Gamma$; $e = (1 - B)^{-1}\ \delta$. The structural form represents equations, each of which defines a basic 'law' or behavioral relation in the model. In the reduced form the value of each endogenous variable is expressed exclusively as a function of the exogenous variables and of the random errors.[1] The reduced form is, in fact, an algebraic transformation which lends itself to estimation and prediction. Both the structural form and the reduced form are subjected to a priori restrictions regarding the

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[1]E. Malinvaud, op.cit., pp. 544-549.

error terms and the components of the B, Γ and Ω matrices. These restrictions categorize interdependent systems varying in aspects of causality and estimation problems.

When applied to the interdependent systems, ordinary least squares estimation procedures yield biased and inconsistent estimates. Research into the development of small bias, consistent estimation techniques led to the discovery of limited and full information maximum likelihood (LIML and FIML) procedures and two and three stage least squares for small systems but leaves much to be desired as systems become large. Formidable computational problems develop in larger systems because the above techniques work via the reduced form from specification of the model.[1] A recent development which sidesteps these problems is known as the fix-point method. The fix-point method, based on a fix-point theorem of construction mapping, was developed by Wold and extended by others.[2] The advantage of this technique is that it focuses on the structural form of the model. The rest of the chapter is devoted to a discussion of two stage and three stage least squares. Maximum likelihood estimation will be discussed in the following chapter when the linear expenditure system is presented.

Two and Three Stage Least Squares

The method of two stage least squares was suggested by Theil[3]

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[1] E.J. Mosbaek and H.O. Wold, Interdependent Systems: Structure and Estimation (New York: American Elsevier Publishing Company, Inc., 1969).

[2] Ibid.

[3] H. Theil, Economic Forecasts and Policy (Amsterdam: North Holland Publishing Company, 1958).

This method ensures consistent estimates in classic interdependent systems of the form

$$Y = By + \Gamma Z + \delta$$

with its reduced form $y = \Omega z + \varepsilon$. The first stage of the procedure involves the estimation of the endogenous variables $y = y^*$ from all the included exogenous variables in the reduced form equation. The next stage is the substitution of the reduced form estimate of the endogenous variable into the structural form, thus replacing y by y^* on the right-hand side of the relation. Then ordinary least squares is applied to the modified structural form to obtain consistent parameter estimates for B, and Γ in the system

$$Y = By^* + \Gamma Z + \delta.$$

The two stage least squares procedure ignores the existence of correlation among residuals in different equations in the system. The method of three stage least squares takes cognizance of the inter-equation correlations and obtains improved estimates of the parameters of the system. This method, developed by Zellner and Theil[1], has its first stage essentially the same as that of two stage least squares. The second stage differs in that y^* is substituted on both sides of the structural form thus

$$y^* = By^* + \Gamma Z + V$$

[1] A. Zellner and H. Theil, "Three Stage Least Squares: Simultaneous Estimation of Simultaneous Equations," Econometrica, XXX (1962), pp. 54 - 78.

and the system solved to obtain a matrix residuals V. The third stage generates the three stage least squares estimates by finding values of B and Γ, which minimizes the function

$$\Sigma\ (y^* - By^* - \Gamma Z)'\ V^{-1}\ (y^* - By^* - \Gamma Z)$$

The estimates of the three stage least squares are thus obtained by the simultaneous solution of the system.[1] If the inter-equation correlations of error terms are not significantly different from zero, the estimates obtained from two stage and three stage squares procedures are identical.

[1] J. Johnston, Econometric Methods (New York: McGraw Hill Book Company, Inc., 1960) pp. 266-268; E.J. Mosbaek and H.O. Wold, op.cit., pp. 440-441.

CHAPTER IV

THE LINEAR EXPENDITURE MODEL

The Model and Its Properties

The linear expenditure model consists of a system of demand equations and has been found to give satisfactory results in the analysis of demand, involving the allocation of total income. The model is of the form:

$$Y_i = P_i X_i = C_i P_i + B_i (M - \sum_{j=1}^{n} C_j P_j) \quad i, j = 1, 2, \ldots, n \quad (4.1)$$

Here P_i and X_i denote the price and quantity, respectively, of the ith commodity; Y_i refers to the expenditure on the ith commodity; and M is the total expenditure on the n commodities. The C_i's and the B_i's are the unknown parameters which are to be estimated. The B_i is the partial derivative of expenditure on the ith good with respect to income, while C_i denotes a basic constant quantity demanded of the ith good. The model stipulates that the consumer first allocates among the various goods and services certain basic expenditures $C_i P_i$ and then allocates the rest of his income to obtaining additional quantities of the various commodities in proportions given by the B_i's. The B_i's may be termed marginal expenditure proportions.

The demand equation as specified in (4.1) satisfies most of the desirable features of demand systems discussed in the last chapter. Since the demand equations are homogeneous of degree zero in prices and income, they satisfy the conditions that (a) the sum of the direct and cross price elasticities and income elasticities equal zero and that (b)

the income elasticities weighted by the expenditure shares sum to unity. By differentiating X_i with respect to P_j and X_i with respect to P_i, it can be shown that the Slutsky condition; namely,

$$\frac{dX_i}{dP_j} + X_j \frac{dX_i}{dY} = \frac{dX_j}{dP_i} + X_i \frac{dX_j}{dY} ,$$

is also met. Also

$$E_y = \frac{dX_i}{dY} \cdot \frac{Y}{X_i} = \frac{b_i Y}{P_i X_i} ,$$

implying that the model assumes that each E_y does not have to be equal to one.[1]

The Evolution of the Model

Since the conception of the model by Klein and Rubin in the late 1940's, there has been a growing body of literature dealing with its theoretical aspects and practical applications.[2] Various extensions to the model have been suggested, and the estimating procedures have improved. Still the search for even more simplified and efficient estimation techniques continue.

Klein and Rubin, in constructing a cost of living index depending only upon observable prices and properties of demand functions, suggested the system of demand equations as shown in (4.1). The assumptions were

(a) a utility function of the form:

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[1]K. Yoshihara, op.cit., pp. 258, 259.

[2]Klein and H. Rubin, "A Constant - Utility Index of the Cost of Living," Review of Economic Studies, XV, pp. 84-87; R. Parks, "Systems of Demand Equations: The Empirical Comparison of Alternative Functional Forms," Econometrica, XXXVII, No. 4 (October, 1969), p. 629.

$$U = U\,(X_i) \qquad i = 1, 2, \ldots, n;$$

(b) the budget constraint

$$\sum_{i=1}^{n} P_i\, X_i = Y$$

(c) condition of utility maximization

$$\frac{dU_i}{dX_1} \,/\, P_i = \frac{dU_2}{dX_2} \,/\, P_2 = \ldots = \frac{dU_n}{dX_n} \,/\, P_n$$

(d) the Slutsky equation

$$\frac{dX_i}{dP_j} = -X_j \frac{dX_i}{dY} + S_{ij}$$

(S_{ij} being the substitution term symmetric in i and j).

The authors showed that the above conditions could be satisfied by the linear expenditure model.

Starting with the Klein demand equations, Greary derived the utility function of the form:[1]

$$U = \sum_{i-1}^{n} (X_i - C_i)\, b_i \qquad (4.2)$$

Samuelson commenting on the implications of linearity made special reference to the Klein-Rubin linear expenditure system concerning its empirical restrictions; namely, (a) that the consumer is assumed always to buy a necessary set of goods, (b) the supernumerary income left after buying the necessary set is allocated in fixed proportions on the various goods,

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[1]R.C. Greary, "A Note on 'A Constant Utility Index of the Cost of Living'," Review of Economic Studies, XVIII (1949-1950), p. 65.

and (c) that the preference function must be as specified in (4.2). Samuelson suggested that the last was a rather highly restrictive empirical assumption and noted that available evidence concerning family budget data was not in accord with this hypothesis.[1]

Perhaps the first practical application of the model was by Stone who used it in the analysis of family expenditure patterns in the United Kingdom. This analysis involved a stochastic specification of the model and additional assumptions concerning the error terms. The parameters were estimated by an iterative process akin to repeated ordinary least squares. Stone's experience led him to suggest that the model might be extended to incorporate specification of the unknown parameters as a function of past consumption.[2]

Since Stone's pioneering work, several students and researchers have applied the model to various data, in many cases making comparisons with other demand functions. Yoshihara applied the model to the Japanese expenditure pattern.[3] The theoretical aspects of the model were compared with three other demand models: the indirect addilog model of Houthakker, the double log system, and Theil's differential model. When the linear expenditure system and Houthakker's indirect addilog system were applied to the data, it was found that the linear expenditure system explained the pattern of Japanese demand far better than the indirect addilog system. The findings were supported by Parks who applied the model along

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[1] P.A. Samuelson, "Some Implications of Linearity," Review of Economic Studies, XX, pp. 88-90.

[2] R. Stone, "Linear Expenditure Systems and Demand Analysis: An Application to the Pattern of British Demand," Economic Journal, LXIV, No. 255 (September, 1959), pp. 511-527.

[3] K. Yoshihara, op.cit.

with the indirect addilog model and Theil's differential system to Swedish data for the period 1861 - 1955.[1]

The models were compared on the basis of (a) the closeness of fit of the models on a commodity by commodity basis, (b) the overall fit of the model to the sample data, and (c) the elasticity estimates. Parks found that the percentage of unexplained variation was low for all the models. Predictions with Theil's differential model for individual commodities were good, but the linear expenditure model (with trend) gave better results for several commodities.[2]

Using annual time series data for the U.S. economy for the period 1949-1965, Pollak and Wales obtained maximum likelihood estimates of the parameters of the model.[3] Their report discussed the problems involved in making systematic use of economic theory to estimate demand functions and the dynamic and stochastic specification of the linear expenditure system. Three estimation techniques were described, and the authors found that the dynamic specification of the model was of crucial importance since different specifications resulted in the widely differing estimates. Also important was the estimation procedure, but different assumptions about the variance of the errors did not affect the estimates to any great extent. The search into a generalized linear expenditure system was suggested by the authors.[4]

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[1] R.W. Parks, _op.cit_.

[2] _Ibid_.

[3] _Ibid_., pp. 625, 626.

[4] _Ibid_., pp. 625-626.

On the Canadian scene, Wales continued work on the maximum likelihood estimation of a generalized linear expenditure system (GLES) as compared with the classic linear expenditure system (CLES).[1] He used Canadian data for four broadly aggregated categories of goods, namely food, clothing, shelter, and a miscellaneous category. Different dynamic specifications of the model were tested as to their effects on elasticity estimates and budget shares. Attention was also paid to different stochastic specifications, the computing procedures and the flexibility of the GLES over the CLES. According to Wales, both gave satisfactory results in terms of elasticity estimates and their statistical properties with little difference in the estimates. The latter form of the model presented greater computational problems and whatever flexibility the GLES had over the CLES was offset by the high additional costs, a fortiori, when large numbers of goods were involved.

Another application of the linear expenditure system to Canadian data for 1947 - 1968 was reported by F. Carlevaro.[2] He also discussed the main problems involved in formulating and estimating semi-aggregated consumption functions based on the utility concept. The demand functions discussed compared the linear expenditure system, both in its conventional form and its generalized form, the direct addilog, and indirect addilog consumption functions. The article also discussed extensions to the conventional linear expenditure system.

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[1] T.J. Wales, "Maximum Likelihood Estimates for Canadian Economy of a Generalized Expenditure System," Discussion paper No. 49 (Department of Economics, The University of British Columbia, March, 1971). This paper has since been published as "A Generalized Linear Expenditure Model of the Demand for Non-durable Goods in Canada," Canadian Journal of Economics, IV, No. 4 (1971), pp. 471-484.

[2] E. Carlevaro, "Formulation et estimation des fonctions de consommation semi-agrégées," The Canadian Journal of Economics, IV No. 4 (1971), pp. 441-470.

Carlevaro tested two different econometric specifications. The first involved the usual stochastic specification in which the error terms are introduced additively with the usual assumption of normal distribution and no correlation. The second form introduced in the same manner a vector of error terms but in association with the budget coefficients. Carlevaro's models were estimated by ordinary least squares and maximum likelihood procedures.

Estimation Procedures

The estimation of the linear expenditure system necessitates the stochastic specification of the model and the making of certain assumptions regarding the errors. Stone in his application suggested an iterative procedure wherein the sum of the squared residuals was minimized over all equations for the time period involved. Initial values for the B_i's were assumed, and these were used to obtain estimates of the C_i's which in turn were used to obtain estimates of the B_i's and so on until covergence was attained.

This procedure has two important limitations. First, because of the restrictions on the model that the sum of B_i's must equal 1, the sum of the errors for each t = 0, resulting in singularity of the covariance matrix E (u'u) and making ordinary least squares estimation inefficient.[1] Omission of one equation from the system eliminates this matrix singularity and allows estimation of all the parameters. Secondly, Stone's estimation procedure does not provide standard errors nor other statistical properties of the estimates. However modification of Stone's

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[1]R.W. Parks, op.cit., p. 643.

procedures provides maximum likelihood estimates of parameters together with the asymptotic standard errors of the estimators.[1] This trend led researchers to probe into the use of maximum likelihood estimation of the linear expenditure system. Since this method of estimation is applied herein, attention is now given to this estimation procedure. The discussion owes much to Parks and Wales.[2]

Stochastic Specification of the Model

The linear expenditure model may be written in stochastic form, allowing the error terms to enter into the model additively. Thus,

$$Y_i = c_i p_i + b_i(m - \sum_{i=1}^{n} c_j p_j) + u_i \qquad i = 1, 2, \ldots, n$$

The Y_i represents a set of T observations over T time periods of the expenditure on the ith commodity. The corresponding prices are given by p_i, and the total expenditure on the n commodities is designated m. The error term which accounts for all unidentifiable factors is labelled u_i. The parameters are unknown and must be estimated.

Because of the constraint in the model that the sum of the b_i's must equal 1.0 and the fact that the total expenditure is a summation of the expenditure on the individual commodities, the error terms must sum to zero. As stated earlier, this necessity makes for singularity of the covariance matrix E(u'u) and the redundancy of any one of the equations in the system when the system is being solved. By omitting one equation from the model and rearranging, one finds

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[1] Ibid.

[2] R.W. Parks, op.cit.; T.J. Wales, op.cit., R.W. Parks, "Maximum Likelihood Estimation of the Linear Expenditure System" (Unpublished paper, The University of Chicago, 1968, Revised December, 1969), pp. 1-11.

$$Y_i - (c_i p_i) = (m - \sum_{i=1}^{n-1} c_i p_i)\, b_i + u_i \qquad i = 1, 2, \ldots, n-1$$

or in more compact notation

$$Y = XB + U \tag{4.3}$$

The above formulation suggests that given estimates of c_i values, estimates of b_i values could be obtained. An alternative formulation which gives an equation for the c_i values suggests that given estimates of b_i values, the c_i values could be estimated. These formulations are made use of in the maximum likelihood estimation of the system.[1]

Assumptions Regarding the Error Terms

The estimation procedure rests upon certain assumptions regarding the errors. It has been suggested that the most appropriate maximum likelihood assumption is to substitute $b_i + u_i$ for b_i in each equation and assume that $E(u_i u_i) = \sigma^2 \hat{X}_i$ and $E(u_i u_j) = 0$, $i \neq j$.[2] Under this assumption the variance of the u_i's is related to the level of consumption x_i of the ith commodity, and the u_i's are not affected by proportional changes in price and income. However, the resulting likelihood function is so complex and difficult to maximize that this approach is of little practical importance.[3]

In this study it was assumed that the error terms u_i ($i = 1, 2, \ldots, n-1$) were normally and independently distributed over time, with a mean of zero and a constant covariance σ^2. Under this assumption, the

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[1] Ibid.

[2] T.J. Wales, op.cit., p. 474.

[3] Ibid.

joint probability density function is given as

$$P(u_i, \sigma^2) = \frac{1}{(2\pi\sigma^2)^{\frac{n-1}{2}}} \exp \frac{u'u}{2\sigma^2} \tag{4.4}$$

When transformed in terms of Y and X in the model (4.3), this function provides a means of estimating the B_i and C_i values of the linear expenditure system (4.4).[1]

Maximum Likelihood Estimates

Given that U = Y - XB from (4.3), the transformation from U_i to Y is given by

$$P\ (Y, \sigma^2, B) = \frac{1}{(2\pi\sigma^2)^{\frac{(n-1)}{2}T}} \exp\ [-\frac{(Y-XB)'(Y-XB)}{2\sigma^2}] \tag{4.5}$$

A similar transformation yields a joint probability density function in terms of C. The right-hand expression in (4.5) is the maximum likelihood function L whose logarithm is given by

$$\log L = K + T/2 \log 1/\sigma^2 - 1/2\sigma^2\ [(Y-XB)'(Y-XB)]$$

To obtain likelihood estimation for L, the exponent in the function must be minimized. Thus when the sum of the squared residuals is a minimum, values of B, C, and σ^2 are maximum likelihood estimators.

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[1] R.W. Parks, "Maximum Likelihood Estimation of the Linear Expenditure System," (Unpublished paper, The University of Chicago, May, 1968, Revised December, 1969), pp. 1-11.

The usual procedure of differentiating the appropriate function with respect to B, C, and σ^2 and equating to zero gives a solution to the problem.[1] In its practical application, the procedure involves alternately estimating B and C using generalized least squares at each stage until convergence is attained. Another approach utilizes the second derivative of the likelihood function with respect to the parameters. The advantage of making use of the second derivative is that convergence is rapid and estimates of the covariance matrix are also obtained.[2]

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[1] Ibid., p. 5.

[2] Ibid., p. 6.

CHAPTER V

CANADIAN CONSUMPTION AND EXPENDITURE PATTERNS

The main determinants of consumption and expenditure are population, income and prices. To highlight the interrelationships, the focus is first placed on a general description of changes in population, income, and prices for the period 1949 to 1969. Following this description is a look at the seven categories of broadly aggregated goods and services, including all foods as a group. Finally, the consumption patterns of meat and dairy products are discussed.

Population, Income, and Price Changes

Population Changes

Important population changes took place in Canada during the last two decades. Population increased from 13.4 million in 1949 to an estimate of just over 21 million in 1971. During the decade 1951 to 1961, 25.5 percent of the increase in population was due to net migration. However, because the immigrants were predominantly British and Europeans, the structural changes that are likely to occur in Canadian eating habits should not be over-estimated since the earlier population was of similar origin.

The population growth -- 54 percent within the last two decades -- is continuing, but at a declining rate. The rate of 2.7 percent in the first decade dropped to 1.9 percent in the following decade. With increasing emphasis on limiting family size, birth control practices, and more selected immigration recruiting policies, the population change is likely to be even less in the decade ahead.

Income Changes

The annual average growth rate of the gross national product in current dollars for the period 1950 to 1961 was 7.3 percent, about 9.0 percent for the period 1961 to 1968, with an overall average of 8.0 percent for the period 1950 to 1968 (Table 5.1). The corresponding percentage figures in constant (1961) dollars were 4.6, 5.8, and 5.1. The compound annual growth rate in real per capita gross national product expressed in constant 1961 dollars was 3.0 percent for the period 1950 to 1968. During the period 1960 to 1968 the compound annual growth rate in real per capita gross national product was 3.3 percent. The annual average rate of increase of personal expenditures for consumer goods and services in constant (1961) dollars were 4.8, 5.2 and 4.9 percent for the periods 1950 to 1961, 1961 to 1968, and 1950 to 1968, respectively.[1]

Price Changes

Economic theory suggests strong relationships between expenditures and income and prices. Price indexes are valuable tools in describing year to year price movements. Price indexes for all sectors showed a general increase during the 1949 to 1969 period, but certain sectors showed marked fluctuations (Table 5.2). For example, the annual farm price index rose from 98.9 in 1949 to 115.0 in 1951 (1961 = 100). By 1955 the index was back to 90.1, after which it rose steadily to 104.3 in 1962. In 1964 the index was 101.3, but climbed to 117.0 in 1966, then dropped to 113.7 in 1968, returning to 117.4 in 1969. These changes clearly demonstrate the instability of farm prices of agricultural products.

[1] Canada Statistics, System of National Accounts - National Income and Expenditure Accounts 1926 to 1968 (Ottawa: Queen's Printer for Canada, August, 1969), p. 15.

Table 5.1

GNP, PERSONAL INCOME, PERSONAL DISPOSABLE INCOME, PERSONAL SAVING, AND SAVING RATIO, CANADA, 1950 TO 1968

Year	GNP	Personal Income	Personal Disposable Income	Personal Saving	Saving Ratio(1)
		millions of dollars			
1950	17,955	13,681	12,704	647	5.1
1951	21,060	16,159	14,803	1,325	9.0
1952	24,040	17,900	16,230	1,319	8.1
1953	25,327	18,932	17,100	1,271	7.4
1954	25,233	19,006	17,157	465	2.7
1955	27,875	20,573	18,639	590	3.2
1956	31,374	22,817	20,593	954	4.6
1957	32,907	24,500	22,044	950	4.3
1958	34,094	25,893	23,555	1,124	4.8
1959	36,266	27,425	24,757	882	3.6
1960	37,775	28,921	25,893	909	3.5
1961	39,080	29,411	26,211	792	3.0
1962	42,353	31,966	28,518	1,565	5.5
1963	45,465	34,109	30,448	1,749	5.7
1964	49,783	36,618	32,853	1,379	4.3
1965	54,897	40,591	35,787	2,249	6.3
1966	61,421	45,702	39,499	2,999	7.6
1967	65,608	50,207	42,791	3,295	7.7
1968	71,454	55,170	46,384	3,516	7.6

(1) Personal Saving as a proportion of personal disposable income.

Source: Statistics Canada, System of National Accounts - National Income and Expenditure Accounts 1926 to 1968 (Ottawa: Queen's Printer for Canada, August 1969), pp. 6, 20.

Table 5.2

SELECTED PRICE INDEXES, CANADA, 1949 TO 1969 (1961 = 100)

Year	Farm Products	Consumer Price Indexes		Industry Selling Price Index[1]	
		Composite	Food	Beef	Pork
1949	98.9	77.4	80.6	-	-
1950	101.0	79.6	82.7	-	-
1951	115.0	88.0	94.4	-	-
1952	106.3	90.2	94.2	-	-
1953	97.0	89.4	90.8	-	-
1954	91.7	89.9	90.5	-	-
1955	90.1	90.1	90.4	-	-
1956	90.9	91.4	91.5	83.0	92.9
1957	91.2	94.3	95.6	83.8	109.0
1958	95.2	96.8	98.5	106.5	101.3
1959	95.2	97.9	97.7	111.2	92.5
1960	96.1	99.1	98.5	101.1	95.7
1961	100.0	100.0	100.0	100.0	100.0
1962	104.3	101.2	101.8	111.4	104.5
1963	102.7	103.0	105.1	105.8	100.3
1964	101.3	104.8	106.8	99.4	96.9
1965	107.8	107.4	109.6	94.9	112.6
1966	117.0	111.4	116.6	114.3	124.4
1967	116.0	115.4	118.1	123.4	110.6
1968	113.7	120.1	122.0	123.4	117.1
1969	117.4	125.5	127.1	136.0	138.3

[1] This series of indexes, which was first published on a 1956 base and then raised to a 1961 base, is a composite index embodying representative sales of individual commodities or commodity groups f.o.b. at the manufacturing plant.

Source: Statistics Canada, Prices and Price Indexes, Cat. No. 62-002 (Ottawa: Queen's Printer for Canada, 1968 to 1971); Statistics Canada, Industry Selling Price Indexes, Cat. No. 62-528 (Ottawa: Queen's Printer for Canada, 1969); Statistics Canada, Canada Year Book (Ottawa: Queen's Printer for Canada, 1949 to 1970).

The consumer price index for food did not experience such marked fluctuations, although the general increase was not smooth. Starting at 100 in 1961, the consumer price index for food rose to 105.1 by 1963, 116.6 by 1966, and stood at 127.1 by 1969. The composite consumer price index during the same period was 103.0 in 1963, 111.4 in 1966, and 125.5 in 1969. These figures indicate a marked stability in prices at the retail level relative to the farm level.

The variations in the industry selling price indexes for beef and pork during the 1956 to 1969 period clearly demonstrate that the price movements for the two products were not necessarily in the same direction or of the same magnitude over time, which imply changes in relative prices.

Aggregate Expenditure Patterns

The description of aggregate expenditure patterns is based on data concerning personal expenditure on consumer goods and services in current dollars for the period 1959 to 1969.[1] The seven broad categories used are: food; clothing; housing; transportation and communication; recreation, education, and entertainment; health; and miscellaneous goods and services. The composition of the various categories are set out in Appendix B.

There was a general increase in expenditure for all categories, but with changing proportions over time. In 1949, food claimed the greatest proportion of consumers' expenditures, followed by housing and the miscellaneous category (Table 5.3). By 1962, housing led in its

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[1]Canada Statistics, "Table 53, National Income and Expenditure Accounts, 1962 to 1969" (Unpublished).

Table 5.3

PER CAPITA EXPENDITURE ON GOODS AND SERVICES, CANADA, 1949 TO 1969

Year	Food	Clothing	Housing	Transportation and Communication	Recreation Education and Entertainment	Health	Miscellaneous
				current dollars			
1949	258.27	97.87	186.81	94.22	38.22	36.67	98.53
1950	273.56	97.14	205.81	111.87	40.26	38.43	107.42
1951	303.09	103.36	219.93	113.07	42.90	42.47	131.63
1952	307.63	109.69	236.81	127.53	48.96	47.17	147.04
1953	303.00	109.86	254.56	135.26	58.54	50.19	147.32
1954	302.23	106.95	267.16	131.22	61.29	54.36	160.14
1955	306.79	109.19	286.09	145.43	65.23	57.71	169.96
1956	322.12	115.04	302.90	156.89	63.37	64.42	185.75
1957	336.48	115.59	313.43	161.53	63.76	69.48	197.17
1958	344.26	117.86	324.71	168.62	68.80	76.41	200.53
1959	351.48	120.29	341.82	178.69	70.53	83.28	204.94
1960	357.64	123.56	345.89	179.46	71.85	89.65	214.44
1961	358.65	124.79	355.96	181.32	77.26	56.80	222.56
1962	370.28	127.80	367.54	195.07	83.57	57.74	231.39
1963	379.43	131.11	385.88	206.91	87.37	61.43	246.16
1964	389.63	136.39	405.70	221.20	96.37	64.70	274.73
1965	407.91	141.52	424.91	241.91	105.27	69.28	295.92
1966	492.63	146.74	451.21	249.66	113.91	73.54	336.80
1967	448.13	154.62	482.48	264.40	129.23	79.34	353.00
1968	466.88	160.91	513.26	282.15	137.68	86.53	394.62
1969	491.38	169.93	554.91	295.05	168.84	82.76	446.47

Source: Calculated from Statistics Canada, "Table 53, National Income and Expenditure Accounts 1962 to 1969" (Unpublished).

claim for the greatest proportion of consumers' expenditure. Food held second place and the miscellaneous category third. The positions for these categories were the same in 1969, but the proportions were changed. The amount spent on food increased at a slower rate than any other category. For example, there was a 97.8 percent increase in food expenditure between 1949 and 1969, as compared with a 251.3 percent increase in the miscellaneous category, a 212.4 percent increase in transportation, and a 207 percent increase in housing. Another rapidly increasing category was recreation, with 230.9 percent.

Food Consumption Patterns

Meat and dairy products constitute two important groups of foodstuffs in the Canadian diet. Figures showing the per capita consumption of these foodstuffs represent a close approximation to the quantities consumed. They are arrived by adjusting domestic supplies at the retail level, taking into account current domestic production, imports, exports, changes in stock, marketing losses, and industrial uses. In the case of meat, the calculations were made at the wholesale level. The food actually eaten is overestimated since (a) losses occuring between retail and actual consumption were not estimated, (b) inventory changes at the retail level were ignored, and (c) only quantities which entered the marketing system were taken into account. Despite these inaccuracies, the figures do represent consistent estimates of the pattern of consumption.[1]

Meat and Poultry

The 1967 to 1969 average per capita consumption of all meat in

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[1] Statistics Canada, Canada Yearbook (Ottawa: Queen's Printer for Canada, 1968), p. 522.

Canada was just under 200 pounds as compared with 237 pounds in the United States. Forty-three percent of the meat consumed in Canada was beef, 27 percent was pork, and 21 percent was poultry. The remaining 9.0 percent consisted of veal, mutton and lamb, offals, and canned meat, averaging for the 1967 to 1969 period only eighteen pounds per capita.

The per capita consumption of beef over the 1949 to 1969 period showed a general increase (Table 5.4). Pork, however, showed a marked fluctuations,ending with a decline. Poultry consumption, like beef, increased, but at a much faster rate. Hiemstra, commenting on a similar United States pattern, suggested that much of the increase in poultry consumption had been associated with technological advances in poultry production, which resulted in progressively lower consumer prices; but, within recent years the continued increase, with little change in relative prices, suggested a definite shift in the demand schedule.[1] Taste changes resulting from continued high consumption in periods of low prices might have been responsible for the demand shift. Based on 1949 being 100, the 1969 consumption indexes for beef, pork, and poultry were 132.7, 94.4 and 270.9, respectively. The corresponding retail price indexes were 178.7, 148.0, and 79.4 (Tables 5.5 and 5.6). The per capita consumption of mutton and lamb increased; but there was a decline in veal, offal, and canned meat consumption over the 1949 to 1969 period.

Dairy Products

Dairy products, as consumed by Canadians, constitute a group consisting chiefly of milk and cream; butter; cheese; concentrated whole

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[1]S.J. Hiemstra, Food Consumption, Prices, and Expenditures, Agricultural Economic Report No. 138 (Washington, D.C.: United States Department of Agriculture, 1968), p. 32.

Table 5.4

PER CAPITA DOMESTIC DISAPPEARANCE OF MEAT, CANADA, 1949 TO 1969

(RED MEAT - COLD DRESSED CARCASS WEIGHT; POULTRY - EVISCERATED WEIGHT)

Year	Beef	Veal	Mutton and Lamb	Pork	Offal	Canned Meat	Total Red Meat	Poultry	Total All Meat
					pounds				
1949	56.7	9.9	2.7	55.0	5.1	4.6	134.0	15.8	149.8
1950	50.8	9.4	2.2	55.0	4.9	5.1	127.4	16.1	143.5
1951	49.3	7.6	2.0	58.6	4.7	5.9	128.1	18.0	146.1
1952	54.4	6.9	2.2	56.0	5.2	7.5	132.2	21.7	153.9
1953	65.1	8.1	2.4	48.7	5.0	5.1	134.4	19.8	154.2
1954	70.2	8.6	2.5	45.4	4.8	4.3	135.8	21.7	157.5
1955	69.1	8.4	2.6	49.2	5.3	4.2	138.8	24.3	163.1
1956	71.4	8.5	2.6	49.2	5.2	4.9	141.8	25.6	167.4
1957	72.0	8.9	2.6	44.4	5.2	4.6	137.7	25.9	163.6
1958	72.0	8.9	2.7	49.4	4.8	5.2	137.4	27.5	164.9
1959	65.6	6.9	2.9	56.7	4.9	4.6	141.6	30.3	171.9
1960	70.0	6.9	2.9	52.6	4.8	6.4	143.6	27.7	171.3
1961	70.5	6.8	3.5	40.3	4.5	4.3	139.9	31.1	171.0
1962	71.1	7.1	3.8	50.1	4.3	4.2	140.6	31.0	176.6
1963	74.3	6.5	4.0	50.7	4.0	4.4	143.9	33.0	176.9
1964	79.4	7.2	3.4	51.8	3.9	4.5	150.2	35.0	185.2
1965	83.6	8.3	2.8	47.9	3.6	4.2	150.4	36.6	187.0
1966	84.1	7.0	3.4	46.9	3.6	4.2	149.2	39.3	188.5
1967	84.0	7.2	3.6	53.8	3.9	4.7	157.2	40.7	197.9
1968	86.7	6.4	4.2	53.6	3.8	4.7	159.4	39.7	199.9
1969	86.4	5.1	4.0	51.9	4.0	4.6	156.0	42.8	198.9

Source: Statistics Canada, Canada Year Book (Ottawa: Queen's Printer for Canada, 1949 to 1971).

Table 5.5

PER CAPITA CONSUMPTION INDEX OF MEAT, CANADA, 1949 TO 1969 (1949 = 100)

Year	Total All Meat	Beef	Veal	Mutton	Pork	Other Meat	Poultry
				percent			
1949	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1950	95.8	89.6	94.9	81.5	100.0	103.1	101.9
1951	97.5	86.9	76.8	74.1	106.5	109.3	113.9
1952	102.7	95.9	69.7	81.5	101.8	130.9	137.3
1953	102.9	114.8	81.8	88.9	88.5	93.8	137.3
1954	105.1	123.8	86.9	92.6	82.5	93.8	137.3
1955	108.9	121.9	84.8	96.3	89.4	97.9	153.8
1956	111.7	125.9	85.8	96.3	89.4	104.1	162.0
1957	109.2	127.0	89.9	96.3	80.7	101.0	163.9
1958	110.1	119.9	73.7	100.0	89.8	103.1	174.0
1959	114.8	115.7	69.7	107.4	103.1	97.9	191.8
1960	114.4	123.4	69.7	107.4	95.6	115.5	175.3
1961	114.2	124.3	68.7	129.6	91.4	90.7	196.8
1962	114.6	125.4	71.7	140.7	91.1	87.6	196.2
1963	118.1	131.0	65.6	148.1	92.2	86.6	208.9
1964	123.6	140.0	72.7	125.9	94.2	86.6	221.5
1965	124.8	147.4	83.8	103.7	87.1	80.4	231.6
1966	125.8	148.3	70.7	125.9	85.3	80.4	248.7
1967	132.1	148.1	72.7	133.3	97.8	88.6	257.6
1968	132.9	152.9	64.6	155.6	97.4	87.6	251.3
1969	132.7	152.4	51.5	148.1	94.4	88.6	270.9

Source: Z. Yankowsky, "The Intermediate and Long Term Market Outlook for Canadian Beef," Proceedings of the 1970 Workshop of the Canadian Agricultural Economics Society (June, 1970), p. 64.

Table 5.6

RETAIL PRICE INDEX OF MEAT, CANADA, 1949 TO 1969 (1949 = 100)

Year	Beef	Pork	Other Meat	Total Red Meat	Poultry	Total All Meat
1949	100.0	100.0	100.0	100.0	100.0	100.0
1950	118.5	98.3	105.6	108.9	96.2	107.1
1951	149.8	111.3	134.2	133.2	113.3	130.3
1952	135.7	97.1	123.1	119.6	100.8	116.9
1953	111.3	106.8	105.7	108.7	108.6	108.6
1954	104.8	111.8	99.8	106.4	95.3	104.8
1955	106.7	98.5	95.4	101.7	93.8	100.5
1956	107.6	99.1	95.9	102.4	91.7	100.8
1957	112.0	117.1	101.1	111.8	88.1	108.3
1958	128.9	113.4	112.2	120.3	87.2	115.5
1959	137.4	105.1	114.4	121.6	79.1	115.4
1960	131.6	103.9	112.6	118.2	80.9	112.8
1961	130.7	113.3	113.7	121.3	72.7	114.3
1962	143.3	116.9	116.8	129.0	74.4	121.0
1963	139.2	117.0	119.6	127.7	76.3	120.2
1964	134.6	114.4	118.3	124.4	72.7	116.9
1965	140.2	127.6	121.3	132.2	74.8	123.9
1966	154.4	147.7	136.6	148.7	80.7	138.8
1967	162.3	133.5	137.0	147.3	77.5	137.2
1968	165.1	132.3	138.1	148.4	79.7	138.4
1969	178.7	148.0	146.2	161.7	79.4	149.8

Source: Z. Yankowsky, "The Intermediate and Long Term Market Outlook for Canadian Beef," Proceedings of the 1970 Workshop of the Canadian Agricultural Economics Society (June, 1970), p. 65.

milk products, dominated by evaporated milk; and concentrated milk by-products, dominated by milk powder. There was, in general, a decline in the per capita consumption of milk and cream and butter from 1949 to 1969 (Table 5.7). The per capita consumption of cheese and concentrated milk by-products, however, increased during the 1949 to 1969 period. The per capita consumption of concentrated whole milk products increased in the decade following 1949, then declined in the next decade, ending with a lower per capita consumption than at the beginning of the period.

There was a general price increase for milk and evaporated milk, with only a small decline in the price of evaporated milk in 1962 and again in 1968 (Table 5.8). The price of butter fluctuated during the entire period. The cheese price fluctuated in the first decade and tended to increase thereafter. A similar pattern was followed by the milk powder price index. The importance of these price changes will later be assessed through regression analysis.

Information From Family Budget Studies

Statistics Canada has, from time to time, conducted and analyzed family expenditure in Canada. In 1969, the first food survey of national scope since 1949 -- and the first to provide separate expenditure estimates for rural and urban families in Canada -- was conducted and the figures are now being prepared for publication. However, some preliminary information is available.

Previously published statistics provided the estimates for urban family food expenditure for 1953, 1955, 1957, and 1962. In 1958 a survey was conducted of farm family living expenditure. However, it did not report a breakdown of expenditure on the various classifications of

Table 5.7

DOMESTIC CONSUMPTION OF DAIRY PRODUCTS, CANADA, 1949 TO 1969

Year	Milk and Cream	Butter	Cheese	Concentrated Whole Milk Products	Concentrated Milk Byproducts
			pounds per capita[1]		
1949	425.79	23.52	5.23	16.39	1
1950	411.59	22.33	5.58	19.26	1
1951	405.62	21.22	5.70	19.92	1
1952	402.54	20.82	5.83	20.30	1
1953	406.15	20.88	6.03	20.78	1
1954	405.20	20.71	6.39	20.51	7.07
1955	411.00	20.63	6.67	20.64	7.42
1956	415.10	20.78	6.35	21.33	7.33
1957	400.17	20.28	6.74	20.84	7.72
1958	396.08	19.13	6.84	20.13	8.88
1959	393.46	18.13	7.00	19.71	9.38
1960	393.20	16.98	7.21	20.18	8.94
1961	332.34	16.49	7.47	19.18	11.00
1962	326.43	17.89	8.5	19.30	10.14
1963	323.40	19.11	8.30	19.09	11.78
1964	321.62	19.03	8.64	18.32	11.93
1965	318.48	18.59	9.13	17.81	11.57
1966	313.17	17.83	9.22	17.34	12.67
1967	303.34	16.91	9.81	16.51	11.48
1968	294.68	16.47	10.34	15.97	12.30
1969	287.06	15.69	11.19	14.62	14.68

[1] Since quantities used for human consumption and as feed could not be separated, no estimates are available.

Source: Statistics Canada, Canada Year Book (Ottawa: Queen's Printer for Canada, 1949 to 1971).

Table 5.8

INDUSTRY SELLING PRICE INDEXES FOR SELECTED DAIRY PRODUCTS

AND MARGARINE, CANADA, 1956 TO 1969 (1961 = 100)

Year	Milk	Butter	Cheese	Evap. Milk	Milk Powder	Margarine
1956	85.3	92.4	97.5	91.2	97.0	109.8
1957	94.2	95.8	102.2	96.7	106.2	113.5
1958	97.3	100.3	101.2	98.4	107.6	106.5
1959	98.8	100.0	105.2	98.4	104.3	102.5
1960	100.0	99.8	99.8	99.4	103.8	96.9
1961	100.0	100.0	100.0	100.0	100.0	100.0
1962	100.7	87.9	102.7	98.8	98.4	93.4
1963	101.8	82.4	108.0	100.8	101.9	89.5
1964	104.4	83.7	109.8	103.2	106.4	94.0
1965	106.6	87.4	117.7	105.8	109.1	107.0
1966	115.4	95.4	125.9	109.7	111.4	108.8
1967	122.7	101.8	132.8	115.6	116.0	105.6
1968	132.1	103.9	135.5	115.3	117.8	104.1
1969	138.6	105.2	135.8	118.4	114.4	106.3

Sources: Statistics Canada, Industry Selling Price Indexes, Cat. No. 62-528 (Ottawa: Queen's Printer for Canada, 1969); Statistics Canada, Prices and Price Indexes, Cat. No. 62-002 (Ottawa: Queen's Printer for Canada, 1969 to 1971).

food items.

This section reports some of the findings of these studies and interprets them in the light of their use in long-term projections. Since the 1958 survey of farm family living expenditure did not give a breakdown on food expenditure, the findings of the other surveys are reported.

Family Food Expenditure, 1953 to 1962

The findings presented here mainly describe the change in family food expenditure between 1953 and 1962 and are based on a five-city composite. Weekly family food expenditure decreased from 1953 to 1955, after which there was a continual increase. The figures were $22.48 for 1953, $21.40 for 1955, $22.70 for 1957, and $23.12 for 1962. The corresponding per capita average weekly expenditure was $6.94, $6.38, $6.56, and $6.77, respectively.

The differences in expenditure during the 1955 to 1962 period did not reflect the complete amount of price change as recorded by the retail food price index for a similar basket of goods. For example, the consumer retail farm price index increased by 6.4 percent between 1957 and 1962, while per capita food expenditure increased by only 3.2 percent. In fact, in terms of 1957 dollars, food expenditures declined approximately 3.0 percent, suggesting a net decline in the physical quantities of goods consumed. This notion was supported by changes in physical quantities of domestic food consumption.

Some of the changes for the two groups of products studies were:

1. Meat -- There was little change in meat consumption between 1957 and 1962. Beef consumption declined about 4 percent, while pork, poultry, and other meat consumption increased 12 percent, 20 percent,

and 12 percent, respectively. A constant dollar decline of 16 percent was reported for beef, but no change in expenditure for pork or other meats was apparent. Poultry consumption was paralleled by a similar increase in constant dollar expenditure.

2. Dairy Products -- In terms of constant dollars, there was a 4 percent decline in the per capita expenditure on dairy products, with a slightly greater percentage decline in per capita consumption. Milk, butter, and evaporated milk declined, while there was increased consumption of cheese and milk powder.

The 1969 Family Food Expenditure Survey

The 1969 family food expenditure survey has been analyzed and will soon be published. This nationwide survey provides estimates of the average expenditure on food for urban families, describes regional differences, and shows how the family food dollar was distributed in 1969. Advance information on the survey indicated that in 1969, rural families spent an average of $2.08 less per capita per week on food than did urban families. Urban families spent an average of $8.56 per person per week with ranges from $8.73 in Ontario to $7.31 in the Atlantic Region. Rural expenditure ranged from $7.43 per person per week in British Columbia, to $6.03 per person per week in the Atlantic Region, giving a national average of $6.48 per person per week.

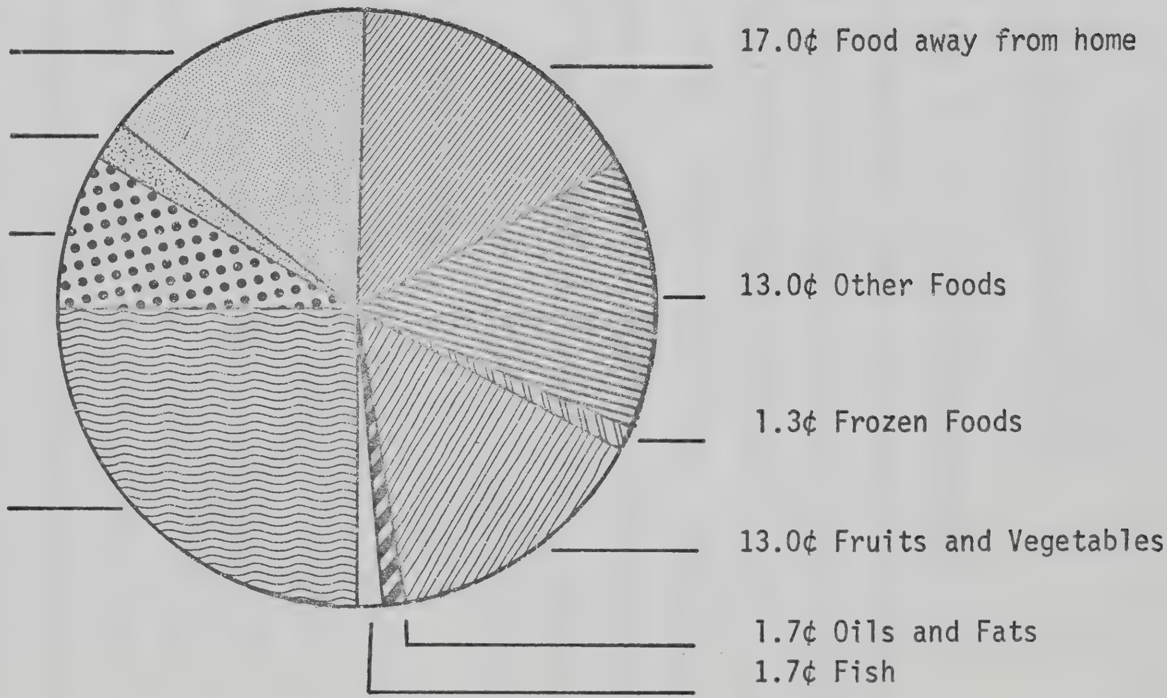
Expenditures on a national basis showed that 25.9 percent of the family food dollar was spent on meat and poultry, 13.4 percent was spent on dairy products, 10.5 percent was spent on bakery and cereal products, 13.0 percent was spent on fruits and vegetables, and so on. (See Figure 5.1 for further details.)

Implications of Budget Surveys

Budget surveys provide data on the consumption pattern of a sample of the population for a specific time period. They show how the samples surveyed allocated their food expenditures among various classifications of food. As such, they bring out the effects of several interacting variables on consumption expenditures. Thus, the resulting distribution of the food dollar takes into account the effect of prevailing prices, level of income, regional and seasonal differences, urban family characteristics, educational status, and social customs. Many of these variables are not measurable on a numerical scale and, even where their effects could be quantified, their future values are difficult to estimate, thus precluding their usefulness in projections. However, based on the distribution pattern of the family food dollar and the projection of total food expenditure, together with certain assumptions, reasonable estimates of the demand for various classifications of food could be obtained by allocating the total food budget in assumed proportions. Such estimates contain information regarding consumer reaction to those factors which influence demand.

Figure 5.1

DISTRIBUTION OF THE FAMILY FOOD DOLLAR, CANADA, 1969



Source: Statistics Canada, "DBS DAILY" (Thursday, December 31, 1970), (Mimeograph).

CHAPTER VI

THE ANALYTIC RESULTS

The Results of the Linear Expenditure Model

The unknown parameters of the linear expenditure system, applied to Canadian data for the periods 1949 to 1969, with other statistical properties, were calculated by maximum likelihood estimation techniques. The related income and price elasticities for the various categories of goods and services were calculated for the end of the period (Table 6.1). Tests of significance were based on the t-statistic. The overall test of the model was based on the level of explained variation for the individual groups as indicated by the R^2 values.

For all categories of goods, and services the basic amount spent at constant (1961) prices, C_i, was positive and significantly different from zero. The highest basic expenditure was on food, \$324.82, followed by housing, \$244.99, the miscellaneous category, \$139.79, and transportation and communication, \$131.48. Basic health expenses were \$89.73, and expenditure on recreation, education, and entertainment was \$57.72. All these estimates are in 1961 dollars per capita. The fact that all these values were positive and significantly different from zero indicated that none of the categories, as specified in the aggregation of consumer goods and services, were considered inferior.[1]

The B_i's indicate the marginal budget share of Canadian consumers during the period 1949 to 1969. That is to say, they show the proportions

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[1]When the results indicate a negative C_i value, the basket of goods is considered unnecessary.

Table 6.1

MAXIMUM LIKELIHOOD ESTIMATES OF THE LINEAR EXPENDITURE SYSTEM

AND OTHER PROPERTIES, CANADA, 1949 TO 1969

Commodity	Basic Expenditure Per Capita (C_i)	Marginal Expenditure Per Dollar of Income (B_i)	Explained Variance (R^2)	Price Elasticity (E_p)	Income Elasticity (E_y)
Food	324.82 (18.88)	0.099 (0.045)	99.34	- 0.260	0.445
Clothing	108.54 (8.54)	0.039 (0.024)*	97.48	- 0.219	0.507*
Housing	244.99 (57.88)	0.327 (0.027)	99.23	- 0.665	1.302
Transportation and Communication	131.48 (37.81)	0.189 (0.022)	98.92	- 0.590	1.415
Recreation, Education and Entertainment	57.72 (20.92)	0.091 (0.021)	96.70	- 0.575	1.191
Health	89.73 (21.20)	- 0.026 (0.610)*	3.08	+ 0.346	- 0.694*
Miscellaneous	139.79 (60.83)	0.281 (0.380)	98.51	- 0.699	1.391

Note: Standard errors of the estimates are in parentheses at the right of the coefficients. The elasticities were calculated for the end of the period 1969.

* Not significantly different from zero (critical level of significance .05). In the case of the income elasticities, the estimates are based on coefficients not significantly different from zero.

in which consumers allocate their supernumerary income in order to buy more of the various goods and services. They are constrained by the fact that the sum of the B_i's must equal one.

All B_i values were positive, except for health, and all were significantly different from zero, save those for clothing and health. The fact that the B_i value for clothing was not significantly different from zero was unexpected since the result indicated an income elasticity not significantly different from zero. The zero or negative income elasticity arising from health is understandable because of the introduction of health plans and the heavy expenditures by government on health care. Housing claimed the highest proportion of the supernumerary income, followed by the miscellaneous category, and transportation and communication, in that order. The marginal budget share for food was 0.099, followed by recreation, education, and entertainment with 0.091.

For each category the amount of variation explained, as indicated by the R^2 values, was high with the exception of health, which was only 3.08 percent. Earlier comments on the B_i value might serve to explain this phenomenon. Of significance in this study is the fact that the model explained 99 percent of the variation in food expenditures (Table 6.1).

Based on the B_i and C_i estimates of the model, the price elasticities (E_p) and the income elasticities (E_y) for the various groups were calculated. The results showed a positive price elasticity and a negative income elasticity for health. Too much emphasis should not be placed on the negative income elasticity since the B_i value from which it was calculated was not significantly different from zero. This comment applies also to clothing.

All other results were as expected on the basis of a priori reasoning and could be explained in economic terms. Where applicable, one could draw from the works of other researchers.

Since the emphasis of this study is on food products, some comparison has been made to other studies on food consumption. The income elasticity for food was 0.45 and the price elasticity was -0.26 (Table 6.1). To make the comparison meaningful, it must be recognised that the food category in this study did include alcoholic beverages, tobacco products, and smokers' accessories.

Wales,[1] using Canadian data for four broad aggregated categories of goods and services, including food as a group, obtained an income elasticity of 0.31. In formulations where the B_i's were allowed to depend on past consumption, the estimated income elasticities were between 0.86 and 0.98. George and King,[2] in a recent study on consumption demand for food commodities in the United States with projections for 1980, constructed a demand matrix similar to that of Brandow.[3] George and King's income elasticity for all food as a group was 0.18, as compared with Brandow's estimate of 0.13. Analysis of household expenditures in the United States by the same authors for 1965 indicated an income elasticity for all food as 0.277 when ordinary regression was used and 0.304 when weighted regression was used. Notwithstanding the inclusion of tobacco

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[1] T.J. Wales, op.cit., p. 477.

[2] P.S. George and G.A. King, op.cit., p. 51.

[3] G.E. Brandow, Interrelations Among Demands for Farm Products and Implications for Control of Market Study, Bulletin 680 (University Park, Pennsylvania: Pennsylvania State University, 1961).

products and alcohol in the food category, the estimate of 0.45 obtained in this study seems reasonable.[1] Due to the lower per capita income in Canada (when compared with the United States), the income elasticity for food in Canada is expected to be higher because a greater proportion of income would be devoted to food (in accordance with Engel's law). George and King concluded from Burk's estimates and their own results for 1955 and 1965 that it appeared that income elasticity for all food expenditures had stabilized around 0.25 and 0.30. One might then expect that in the decades ahead a similar pattern may occur in Canada.

Turning to price elasticity estimates, Wales obtained direct price elasticities ranging from -0.27 to -0.39 with different specifications of the linear expenditure model.[2] In the United States several studies have reported varying price elasticities.[3] Hiemstra, using annual

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[1]George and King, op.cit., p. 82 also cited that Burk (1951) estimated income elasticities in 1935-1936, 1941 (two), 1944, and 1957 using cross-section data in the United States according to the following regressions:

1935 - 1936	$\log X_1$	$= 0.88 + 0.49 \log Y_1; R^2 = 0.99$
1941	$\log X_1$	$= 0.93 + 0.49 \log Y_1; R^2 = 0.99$
1942	$\log X_2$	$= 0.64 + 0.58 \log Y_2; R^2 = 0.99$
1944	$\log X_3$	$= 1.47 + 0.33 \log Y_2; R^2 = 0.95$
1957	$\log X_2$	$= 1.61 + 0.31 \log Y_2; R^2 = 0.96$

where

X_1 = average expenditure per capita for food and alcoholic beverages, total population;

Y_1 = average per capita disposable income, current dollars, total population;

X_2 = food expenditure per capita, urban families, current dollars.

[2]T.J. Wales, op.cit., pp. 477-478.

[3]S.J. Hiemstra, op.cit.; F.V. Waugh, Demand and Price Analysis: Some Examples from Agriculture, Technical Bulletin No. 1316 (Washington, D.C.: Economic and Statistical Division, United States Department of Agriculture, 1964); G.E. Brandow, op.cit.; P.S. George and G.A. King, op.cit.

data for 1948 to 1966, reported the price elasticity for food as -0.18. Waugh's estimate, using 1948 to 1962 data, was -0.24. Brandow's study indicated the price elasticity for food as being -0.34, which Brandow himself thought slightly too high. George and King's results showed the price elasticity for food to be -0.24. It appears, therefore, that an estimate of -0.26 for the Canadian economy is rather reasonable (Table 6.1).

The results from the linear expenditure system have important implications for forecasting. Using the model as specified in this study, the aggregated demand for food can be projected on the basis of the calculated income and price elasticities, given appropriate assumptions about prices and incomes. Another approach would be to project total expenditures and use the B_i and C_i estimates to arrive at expenditures on the various categories of goods and services with the appropriate assumptions regarding relative prices.

Analysis of Budget Proportions

Examination of the data revealed little variation in the budget proportions for meat during the entire period 1953 to 1969. There was a general decline in the budget proportion devoted to dairy products, while the budget proportion devoted to food consumed away from home showed a marked increase. Analysis of the data to ascertain trend patterns supported these observations (Table 6.2). As expected, there was no significant trend in the budget proportion devoted to meat as indicated by the non-significant F-value. The b coefficient was not significantly different from zero at the 10 percent level of significance as tested by the t-statistic. There was a significant downward trend in

Table 6.2

TREND ANALYSIS OF BUDGET PROPORTIONS, FOR SELECTED FOOD CATEGORIES, CANADA,

SELECTED SURVEY YEARS 1953 TO 1969

Food Category	Mean	S.D.	a	b	F	R^2	Equation
Meat	25.86	0.87	25.22	0.070 (0.066)	1.11	27.01	6.3.1
Dairy Products	14.88	1.00	16.25	-0.149 (0.026)	34.17	91.9	6.3.2
Food Away From Home	12.08	2.97	7.99	0.445	36.96	92.5	6.3.3

Note: The standard errors are in partentheses beneath the coefficients.
S.D. = Standard Deviation
a = Intercept Term
b = The Slope Coefficient
F_2 = The F-statistic
R^2 = The Multiple Correlation Coefficient

The trend model was of the form $BP = a + bT + e$ in which BP represented the budget proportion, T the time, e the error term and b the slope coefficient.

the budget allocated for dairy products. The F-value indicated this significant relation at the 10 percent level. The resulting R^2 was 92 percent. The t-statistic indicated that the b coefficient was significantly different from zero. For food consumer away from home there was a positive trend, as shown by the b coefficient of 0.45, which was significantly different from zero. The F-value indicated a significant relationship between the dependent and independent variable. The R^2 was 94 percent.

The preceding analysis suggests a relative constancy in the budget proportion devoted to meat, a general decline in the budget for dairy products, and an increase in the budget proportion allocated for food consumed away from home. The downward trend in the budget proportion allocated for dairy products does not necessarily imply a downward trend in expenditures on dairy products. This depends on whether the positive increase in food expenditures out-weighs the downward effect of the budget proportions devoted to dairy products. In addition, some assumptions must be made regarding the proportions of the various food categories constituting food consumed away from home.

Results From Single Equation Regression Analysis

The Models

Based on the price, consumption, and income statistics discussed in the previous chapter, single equation demand models were tested for selected commodities and commodity groups. The coefficients of the models were estimated by ordinary least squares in which the variables affecting quantity demanded were listed in the order of importance. The F-statistic and Student's t-statistic were used to test the significance

of the regression equations and the individual coefficients, respectively. The multiple correlation coefficient, R^2, showed, in the dependent variable, the amount of variation that was explained by the independent variables. The Durbin-Watson d-statistic was used to test evidence of serial correlation. The significance level was set at 0.05 for the regression equation and any coefficient which was not significantly different from zero at the 0.10 level was omitted from the equations.

The following results were obtained from models of the form:

$$\text{Log } Q = \log a + b_1 \log P_1 + \ldots + b_n \log P_n + C \log Y + d \log T + e \text{ ,}$$

in which

Q = index of quantity demanded, $P_1 \ldots P_n$ = industry selling price indexes for commodity Q and other competing commodities, Y = index of per capita disposable income, T = time, and a, $b_1 \ldots b_n$, c, d are unknown parameters to be estimated. Prices were deflated by the non-food consumer price index and income was deflated by the consumer price index.

<u>Meat Products</u>

Beef -- Income denoted by Y and price of beef, P_1, were the significant variables explaining the consumption of beef, Q_1, as shown in the following equation:

$$\text{Log } Q_1 = 1.100 + \underset{(0.2027)}{0.8534} \log Y - \underset{(0.0414)}{0.4051} \log P_1 + e \qquad (6.1)$$

$R^2 = 98.9$ F-value = 495.8 d-statistic = 1.98

The variables accounted for 99 percent of the variation in beef consumption. The results were highly significant and there was no evidence of serial correlation. The price and income elasticities for beef were

-0.41 and 0.85, respectively, and were significantly different from zero at the 0.01 level of significance. When other variables, such as the price of pork, lamb, or veal, were included in the regression equation, the explanatory power of the model was improved slightly, but none of the additional coefficients were isgnificantly different from zero.

Pork -- The quantity of pork consumed was regressed against the quantity of beef consumed, the price of pork, and the price of lamb. The following equation was obtained:

$$\text{Log } Q_2 = 2.9843 - \underset{(0.2745)}{1.1092} \log P_2 + \underset{(0.3894)}{1.2466} \log P_3 - \underset{(0.3224)}{0.6023} \log Q_1 + e \qquad (6.2)$$

$R^2 = 65.56$ F-value = 6.35 d-statistic = 2.94.

In Equation (6.2) Q_2 refers to the quantity of pork consumed; P_2, the price of pork; P_3, the price of lamb; and Q_1 the quantity of beef consumed.

The model explained only 66 percent of the variation in pork consumption and, at the 0.05 level of significance, the model must be rejected. But, it was isgnificant at the 0.10 level. All coefficients were significantly different from zero at the 0.10 level. The price of pork and the price of lamb were the most important variables -- the price elasticity of demand for pork being -1.11 and the cross-price elasticity of demand with respect to the price of lamb being 1.25. The inclusion of the price of beef, instead of the quantity of beef, in the model showed a high cross-price elasticity of demand (1.08) for pork with respect to beef when the price of veal was also included. This

figure fell to .34 when the price of veal was omitted. The income elasticity was not significantly different from zero. However, the statistical properties of the model were less desirable. The d-statistic indicated no autocorrelation.

Mutton and Lamb -- The important variables in the consumption variation of mutton and lamb were the price of beef, price of veal, and the price of lamb, as is shown by the following equation:

$$\text{Log } Q_3 = 2.0828 + \underset{(0.6370)}{3.6246} \log P_4 - \underset{(0.6509)}{2.3372} \log P_1 - \underset{(0.3961)}{1.3225} \log P_3 + e \qquad (6.3)$$

$R^2 = 83.66$ F-value = 17.07 d-statistic = 1.87.

The amount of variation explained by the three variables was 84 percent and the F-value indicated that the relationship stipulated in the model was highly significant. There was no autocorrelation as shown by the d-statistic. When income and the price of pork were included in the regression, the resulting coefficients were not significantly different from zero. The low cross-price elasticity between lamb and beef showed that lamb was not a close substitute, but a high substitutability was indicated for veal -- the cross-price elasticity being 3.62.

Veal -- Price was the significant variable in explaining variation in veal consumption. All other variables included in the regression equation resulted in some increase in the explanatory power of the model, but the resulting coefficients were not significantly different from zero. The relationship is shown by the following equation:

$$\text{Log } Q_4 = 4.4134 - \underset{(0.2090)}{1.1889} \log P_4 + e \qquad (6.4)$$

$R^2 = 71.06$ F-value = 29.47 d-statistic = 1.204.

The price of veal accounted for 71 percent of the variation in veal consumption. The relationship was highly significant and the evidence regarding autocorrelation was inconclusive. The generated price elasticity for veal was -1.19.

Poultry -- Using reatil prices and income data for the period 1949 to 1969, it was found that the variation in poultry consumption could be explained by the price of poultry and income according to the following equation:[1]

$$\text{Log } Q_5 = 1.34217 + \underset{(0.1687)}{0.94499} \log Y - \underset{(0.1123)}{0.6232} \log P_5 + e \qquad (6.5)$$

$R^2 = 97.72$ F-value = 385.15 d-statistic = 1.45.

In Equation 6.5, Q_5 is the quantity of poultry meat consumed and P_5 is the price. The equation was highly significant in explaining variation

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[1] Using similar data for beef, pork, and poultry, Z. Yankowsky, op.cit., p. 57 reported the following results:

$$\log q_1 = 1.29 - \underset{(.04)}{.74} \log p_1 + \underset{(.07)}{.16} \log p_2 - \underset{(.05)}{.09} \log p_3 + \underset{(.07)}{.88} \log i \qquad R^2 = .99$$

$$\log q_2 = 1.17 + \underset{(.10)}{.63} \log p_1 - \underset{(.15)}{.47} \log p_2 + \underset{(.11)}{.09} \log p_3 + \underset{(.17)}{.005} \log i \qquad R^2 = .75$$

$$\log q_3 = .87 - \underset{(.12)}{.12} \log p_1 - \underset{(.18)}{.21} \log p_2 - \underset{(.14)}{.56} \log p_3 + \underset{(.21)}{1.07} \log i \qquad R^2 = .98$$

q_1 = per capita consumption of beef p_1 = retail price of beef
q_2 = per capita consumption of pork p_2 = retail price of pork
q_3 = per capita consumption of poultry p_3 = retail price of poultry
i = personal disposable income per capita (prices and income deflated by the consumer price index).

in poultry consumption. The model explained 97.72 percent of the variation and the evidence regarding autocorrelation was inconclusive. The price and income elasticities were -0.62 and +0.95, respectively. The inclusion of prices of other meats added little to the explanatory power of the model since the resulting coefficients were not significantly different from zero and the increase in the amount of explained variation was negligible.

All Meat -- The quantity of total meat consumed was regressed on price and income. The resulting equation was:

$$\text{Log } Q_6 - 1.723 + \underset{(0.0244)}{0.5713} \log Y - \underset{(0.0479)}{0.1587} \log p_6 + e \qquad (6.6)$$

$$R^2 = 97.58 \qquad \text{F-value} = 362.81 \qquad \text{d-statistic} = 2.043.$$

In the above equation, Q_6 represents quantity of meat consumed and p_6 refers to the price. The relationship explained 97.58 percent of the variation in meat consumption, which was highly significant, and there was no evidence of autocorrelation. The income and price elasticities were 0.57 and -0.16, respectively, and they were significantly different from zero.

Dairy Products

In general, regression results were less satisfactory for dairy products than for meat. In all cases the cross-price elasticities among dairy products were not significantly different from zero. There was a significant cross-price elasticity between butter and margarine, as might be expected from *a priori* reasoning. The poor results of models involving income and prices led the author to include time in many of the equations. This variable, which might be regarded as a proxy for other

unidentified variables, gave significant results of the trends in consumption of many dairy products. Such information could be quite valuable in making projections.

Milk -- The consumption pattern of milk and cream was explained by income and time according to the following equation:

$$\underset{}{\text{Log } Q_7 = 2.91366 - \underset{(0.0304)}{0.0997} \log Y - \underset{(0.1959)}{0.4031} \log T + e} \qquad (6.7)$$

$$R^2 = 89.29 \qquad \text{F-value} = 45.83 \qquad \text{d-statistic} = 1.33.$$

Milk consumption is represented by Q_7, while the other variables are as defined previously. The two variables explained 89 percent of the variation in milk consumption and the coefficients were significant at the 10 percent level. The regression was significant at the .01 level. Both the income elasticity and the time trend were negative, indicative of the declining per capita consumption of milk. Inclusion of price in the regression indicated a positive price elasticity, but it was not significantly different from zero. Prices of evaporated milk and milk powder had no significant effects on milk consumption.

Butter -- Price of butter, price of margarine, income, and time were important variables affecting butter consumption. When consumption of butter was regressed against these variables, the following results were obtained:

$$\begin{aligned} &\text{Log } Q_8 = 2.9860 + \underset{(0.1442)}{0.7623} \log P_7 - \underset{(0.1613)}{0.8433} \log P_8 - \underset{(0.2266)}{0.3975} \log Y + e \\ &R^2 = 88.36 \qquad \text{F-value} = 21.11 \qquad \text{d-statistic} = 1.65 \end{aligned} \qquad (6.8)$$

and

$$\text{Log } Q_8 = 2.8454 - \underset{(0.0243)}{0.0975} \log T - \underset{(0.1427)}{0.7980} \log P_8 + \underset{(0.1792)}{0.4191} P_7 + e \quad (6.9)$$

$R^2 = 88.68$ F-value = 26.11 d-statistic = 1.25.

In the above equations: Q_8 refers to butter consumption; P_7, the price of margarine; P_8, theprice of butter; other variables are as previously defined. Equation (6.8) indicated an income elasticity of -0.40, which was significantly different from zero. Direct-price elasticity and cross-price elasticity, with respect to the price of margarine, were -0.84 and +0.76, respectively. When time replaced income in the model they were -0.80 and -0.42, respectively (Equation 6.9). Replacing income by time increased both the R^2 and the F-value of the model; but, whereas the d-statistic in Equation 6.8 indicated no serial correlation, evidence regarding serial correlation in Equation 6.9 was inconclusive.

Cheese -- Price of cheese, income, and time were important variables explaining variation in cheese consumption according to the following equation:

$$\text{Log } Q_9 = 0.2023 + \underset{(0.1554)}{1.3516} \log Y + \underset{(0.0173)}{0.0425} \log T - \underset{(0.2154)}{0.4717} \log P_9 + e \quad (6.10)$$

$R^2 = 98.91$ F-value = 301.84 d-statistic = 3.35.

The variables explained 98.9 percent of the variation in cheese consumption. The income elasticity was 1.35 and highly significant. The price elasticity was -0.47 and the time trend was positive. There was no evidence of serial correlation as indicated by the d-statistic.

Concentrated Milk Byproducts -- Time and income were the important variables affecting the consumption of concentrated milk byproducts. The effect of time, however, dwarfs the income effects into insignificance. When the consumption

of concentrated milk byproducts was regressed against time the following equation was obtained:

$$\text{Log } Q_{10} = 1.7912 + \underset{(0.0248)}{0.2419} \log T + e \tag{6.11}$$

$R^2 = 88.76$ F-value = 94.76 d-statistic = 2.26.

Eighty-nine percent of the variation in concentrated milk byproduct consumption was explained by the time trend and there was no evidence of serial correlation indicated by the d-statistic. The F-test showed a highly significant relationship. There was no significant relationship between the price of evaporated milk or milk powder on the pattern of consumption

Concentrated Whole Milk Products -- There was an inverse relationship between the growth in income and consumption of concentrated whole milk products. Other variables, such as the price of milk powder, price of evaporated milk products, and time, did not show any significant effects on the consumption pattern. The equation resulting from regressing consumption of concentrated whole milk products on income was as follows:

$$\text{Log } Q_{11} = 3.7648 - \underset{(0.0678)}{0.8711} \log Y + e \tag{6.12}$$

$R^2 = 93.23$ F-value = 165.25 d-statistic = 1.44.

The relationship explained 93 percent of the variation in concentrated whole milk consumption. The resulting income elasticity was -0.87 and was significantly different from zero. Evidence regarding autocorrelation was inconclusive.

The negative income elasticities for milk, butter, and

concentrated whole milk suggest that these products are "inferior" choices for high income consumers who might substitute higher quality foods of these products. Models constructed to explain variation in dairy product consumption should probably go outside the realm of prices and income and take into account variables relating to tastes and preferences, medical findings, and the like.

CHAPTER VII

PROJECTIONS OF DEMAND TO 1980

Trends in consumption and expenditure on various commodity groups have been described. An analysis of these trends will be undertaken to establish econometric relationships among the variables so that use can be made of these relationships in the projection of demand for 1980 of the two groups of agricultural commodities. However, before this is done, a review of some basic concepts and considerations regarding conditional quantitative economic projections and demand projection methods is given.

Conditional Quantitative Economic Projections

Conditional quantitative economic projections state future outcomes of one or more economic variables, describing these outcomes with one or more numbers and specifying the occurrence or absence of some other more basic events on which the outcomes depend. When a single number describes the outcome of a particular event, the projection is called a point projection. On the other hand, interval projections give a set of situations usually described as pairs of numbers, one pair of which is expected to be realized. A single projection refers to statements about one event, or one aspect of an event, and is designated by a single number for a point projection or a pair of numbers for an interval projection. Multiple projections are statements about several events, or several aspects of a single event, and are designated by several numbers or pairs of numbers. Projections may take the form of several

combinations of these distinctive categories.[1]

There are certain desirable standards which projections should meet. The first is that of verifiability. At the future time specified it must be possible to conclude without doubt whether or not the projections were realized, and it should also be possible to verify the procedures by which the projections were made. This condition of verifiability implies the explicit statement of the basic concepts and conditions of the projections and the specific time period involved. Another implication of verifiability refers to the relationship between the projection and the actual outcome of the event. It is not necessary for the projected value to always be equal to the actual outcome, but the resulting prediction errors should have certain desirable properties.[2]

Second, projections must be reliable. The making of projections is not an end in itself, but a necessary part in the decision-making process. Failure to arrive at a reliable estimates of future outcomes could have disastrous results when decisions are based on these estimates. In economic planning, the reliability of economic projections are of utmost importance, especially when a substantial time span is envisaged. In the long-run, structural relationships would change, thus making the reliability of quantitative economic projections a rapidly diminishing function of time.

Methods of Demand Projections

The factors affecting demand have been discussed and the influence of some of these factors was measured in relation to the

[1]H. Theil, op.cit., pp. 1-10.

[2]Ibid.

consumption of seven broad categories of consumer goods and services (including food as a group) and two broad categories of food. All the factors discussed influence the long-run change in per capita consumption of and expenditure on different food commodities and food as a group. Such factors include: changes in relative prices, income and wealth, tastes and preferences, the age composition of the population, product innovations, educational status, degree of urbanization, and a host of others. In the long-run all these factors are mutable. It is impossible to obtain future estimates of all these factors; therefore, certain constraints must be imposed when making demand projections. What then are the possibilities open to us, given the econometric relationships obtained in the analysis? The following alternatives might be pursued.

Projections with Constant Demand Elasticities

Price and income elasticities may be used in the projection of future consumption and according to the following equation:

$$Q = m \times p \,, \tag{7.1}$$

where Q is a vector of quantities, m is a matrix of price and income elasticities, and p is a vector of projected or assumed values of prices and income.[1] Such a formulation implies constant demand elasticities.

The introduction of a time trend may improve the projection. The value of Q obtained from Equation 7.1 is modified on the basis of an annual time trend expressed as a percentage per annum change, provided that the trend is significantly different from zero. The future level

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[1] P.S. George and G.A. King, op.cit., p. 95.

of consumption is thus specified according to the compounding equation

$$Q_t = Q_t (1 + S_i)^K , \qquad (7.2)$$

in which Q_t is the estimated consumption level based on Equation 7.1, S_i is the percentage change per annum, and K is the number of time periods involved.[1]

The matter of price projection deserves some comment. As stated earlier, price formulation involves both demand and supply considerations and institutional elements within the marketing system. This combination of factors leads to difficulties when making reliable estimates of prices in the long-run. In general, researchers make the assumption of constant relative prices for a particular base period. Although this is a strong assumption, the projections could be verified in relation to changes in relative prices.

Projections with Changing Demand Elasticities

Demand elasticities are usually calculated for a particular time period. When calculated for different time periods, the resulting estimates differ even when based on the same estimating equation. By calculating elasticities for different years, a pattern of demand elasticity change may be discerned. Taking account of this changing pattern of demand elasticities provides another method for incorporating dynamism into the making of projections. Instead of the inclusion of a simple time trend, the trend from the demand elasticities is used in Equation 7.2 to project the level of consumption.

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[1] *Ibid*.

<u>Other Methods</u>

Given an estimate of the demand for food as a group, it is possible to allocate food expenditure on the various classes of foods, assuming certain values of expenditure proportions are assigned to those classes. The demand projection for food as a group might depend on one or another of the aforementioned methods. Econometric relationships provide the basis of calculating demand elasticities. Instead of first calculating these elasticities, which invariably result in holding other variables in the model constant, one might use the basic coefficients to estimate demand, given values for the dependent variables. Where it is desirable to make interval projections, the standard errors of these coefficients might be used to establish upper and lower boundaries for the projections. Thus, the interval could be established by using one or two standard errors or so about the estimating coefficients.

Two types of projection approaches were used in this study. The first was based on a demand for food and an allocation of the demand expenditure on meat and dairy products, according to assumed budget proportions. The demand for food was estimated from the relationships obtained from the linear expenditure system and an estimating equation which related expenditure as a function of GNP and the previous expenditure level. The second approach utilized price and income elasticities and trend estimates derived from regression analysis to project quantities consumed, which when multiplied by 1969 prices, gave the expenditure on that particular commodity or group.

Projection Methods of This Study

Method I: The Linear Expenditure System -- Budget Proportions Approach

The linear expenditure model was used to estimate the total expenditure on food in 1980. Based on an analysis of budget proportions and estimates for 1980, the amounts allocated to meat and dairy products for this time were derived. It was assumed that the real per capita gross national product in Canada would increase at a rate of 3.3 percent per annum up to 1980. Calculations were based on 1969 dollars and constant 1969 relative prices.

Total per capita expenditure on all goods and services was estimated from the following relationship:

$$PCEXP_t = 3.6722 + \underset{(0.0431)}{0.3972}\,GNP_t + \underset{(0.0532)}{0.5882}\,PCEXP_{t-1} + e \qquad (7.3)$$

$$R^2 = 99.88 \qquad F = 6154.01 \qquad \text{d-statistic} = 1.686.$$

In the above equation $PCEXP_t$ denotes an index of per capita expenditure on consumption goods and services, the subscript, t-1, denotes that the variable is lagged one year, and GNP_t refers to an index of per capita gross national product. A logarithmic function was specified and least squares procedures were used to estimate the coefficients. The standard errors are in parentheses beneath the coefficients. All coefficients were significantly different from zero. The equation indicated a high correlation between the dependent and independent variables resulting in a multiple correlation coefficient of 99.88. The d-statistic indicated no evidence of serial correlation. The introduction of another lagged variable, ($PCEXP_{t-2}$) did not improve the relationship and the resulting coefficient was not significantly different from zero.

The per capita expenditure for 1980 estimated from Equation 7.3 was $2990.54, and the expenditure on food, based on the results of the linear expenditure model, was calculated at $525.61 per capita. An adjustment was made in this estimate to omit expenditure on alcohol and tobacco products, which were included in the food category. The adjustment was based on the 1961 to 1969 average proportion of expenditure on food and non-alcoholic beverages relative to total expenditure on food, including alcohol and tobacco products. This proportion averaged 0.76445. When the adjustment was made, the per capita food expenditure in 1980 was estimated at $401.80.

The next step was to estimate what proportion of food expenditure would be devoted to meat and dairy products. The analysis of budget proportions in Chapter VI, although based on five observations, covered a long time period. The results of the analysis were used to estimate budget proportions for meat and dairy products and food consumed away from home. The results indicated that budget proportions on meat, dairy products, and food consumed away from home would be 25.9, 11.8, and 21.3 percent respectively.

For the period 1953 to 1969 the expenditure proportion on meat averaged 25.9 percent, while dairy products averaged 14.9 percent. Yankowsky reported that expenditure on meat was the highest of all groups of food commodities, ranging from about 30 percent in the mid-fifties, to over 30 percent in the early sixties, and reaching an estimated 35 percent in 1969.[1] It appeared that slightly over half of the expenditures on food consumed away from home was related to meat consumption. The

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[1]Z. Yankowsky, op.cit., p. 53.

analysis of budget proportions indicate that expenditure on food away from home would reach 21.3 percent by 1980 (Equation 6.3, Table 6.2). By this time meat expenditures would claim an estimated 37 percent of the total food basket. Projection of the budget proportion devoted to dairy products (Equation 6.3, Table 6.2) and the assumption that expenditure on dairy products away from home would be in the same proportion as at home, indicate expenditure on this group for 1980 would be 15 percent. Based on these expenditure proportions, the expenditures on meat and dairy products were estimated, as is illustrated in Table 7.1.

Table 7.1

ESTIMATED PER CAPITA

EXPENDITURES ON MEAT AND DAIRY PRODUCTS IN CANADA

FOR 1969 AND 1980

Commodity	1969 Expenditure	1980 Expenditure
	1969 dollars	
Meat and Poultry	126.86	148.67
Dairy Products	58.50	60.27

Method II: Individual Commodities -- Linear Regression Approach

The regression equations given previously were used for estimating quantities of the various kinds of meat and dairy products expected to be consumed in 1980 (Table 7.2, 7.3). Prices for 1969 were calculated by dividing the average per capita expenditure on various kinds of meat and

Table 7.2

MEAT: CANADIAN PER CAPITA CONSUMPTION AND EXPENDITURE IN 1969 AND 1980

Commodity	1969 Cons.	1969 Price	1969 Exp.	Estimating Equation	1980 Cons.	1980 Exp.
	lbs.	$	$		lbs.	1969 dollars
1. Beef	86.4	0.819	53.07	(6.1.1)	115.2	70.76
2. Pork	51.9	0.813	31.65	(6.1.2)	56.0	34.14
3. Mutton and Lamb	4.0	0.719	2.07	(6.1.3)	4.0	2.07
4. Veal	5.1	1.000	3.83	(6.1.4)	5.8	4.35
5. Poultry	42.8	0.500	21.40	(6.1.5)	60.0	30.00
6. Other Meat	8.6	0.681	5.86		8.0	5.45
Total	198.8		117.88		249.0	146.77

Table 7.3

DAIRY PRODUCTS: CANADIAN PER CAPITA CONSUMPTION AND EXPENDITURE IN 1969 AND 1980

Commodity	1969 Cons.	1969 Price	1969 Exp.	Estimating Equation	1980 Cons.	1980 Exp.
	lbs.	$	$		lbs.	1969 dollars
Fresh Milk	287.06	0.116	33.30	(6.2.1)	233.9	27.13
Butter	15.69	0.700	10.99	(6.2.2)	15.3	10.71
Cheese	11.19	0.780	8.74	(6.2.4)	17.7	13.81
Concentrated Milk Byproducts	14.68	0.390	5.73	(6.2.5)	15.7	6.12
Concentrated Whole Milk Products	14.62	0.210	3.07	(6.2.6)	11.2	2.35
Total	343.24		61.83		291.8	60.12

dairy products by the average per capita consumption of the commodity in question.[1] In computing the expenditures on various meat products, the quantities of beef, veal, pork, mutton and lamb were first converted into retail quantities, since the data and estimates were based on carcass weight. A conversion factor of 0.75 was used for beef, veal, and pork, and 0.72 was used for mutton.[2] Calculations were based on constant 1969 dollars and constant 1969 relative prices. Per capita disposable income was estimated at $3313 in 1980.[3]

A Comparative Analysis

An attempt was made to compare the results of the two approaches. The basic objective of the study was to provide conditional estimates, in expenditure form, for the meat and dairy products. This could be used in an input-output household final demand vector. Method I utilized

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[1]Average per capita expenditure and average per capita consumption data are given in Statistics Canada, Family Food Expenditure in Canada, 1969, Cat. No. 62-531 (Ottawa: Queen's Printer for Canada, 1971).

[2]These estimates were based on the information received from persons involved with carcass cut out. These persons included Drs. R.T. Berg and D.R. Clandinin (Department of Animal Science, University of Alberta).

[3]This estimate was based on an estimating equation similar to (7.3) relating per capita personal disposable income to gross national products. Thus,

$$\log \gamma = 0.2112 + \underset{(0.0204)}{0.8897} \log G + e$$

in which γ denotes an index of real per disposable income and G denotes an index of per capita gross national product. The relationship was highly significant and explained 99 percent of the variation in disposable income.

an allocation procedure: first projecting food expenditures based on the linear expenditure system, then allocating the projected food expenditures to meat and dairy products, based on an analysis of budget proportions. Method II made use of conventional regression analysis in estimating price and income elasticities and in projecting quantities of individual commodities. These quantities were then multiplied by their corresponding 1969 prices to estimate the expenditures. The two approaches gave fairly close results. Based on budget proportions, the 1969 per capita expenditures on meat and dairy products were $126.86 and $58.50, respectively. Based on the consumption estimates for the various categories of meat and dairy products and calculated 1969 prices, the estimated per capita expenditures were $117.88 and $61.83 for meat and dairy products, respectively. The higher estimate for meat products generated from the expenditure proportion is reasonable since food eaten away from home is more costly, because of the additional services that go with it. This situation, however, was not exhibited by the estimates for dairy products. They indicated a higher estimate when using the individual product basis than when using the budget proportion, although the estimates were close.

When the projected expenditures were compared, the estimates were even closer. Both approaches showed an increase in the consumption of meat products, whereas Method I showed a small increase in the consumption expenditure of dairy products, while a decline was indicated by Method II. Consumption expenditure on meat and dairy products were estimated at $148.67 and $60.27, respectively, using Method I. The corresponding estimates from Method II were $146.77 and $60.12. As expected, Method I gave higher estimates than Method II, but the differences were

expected to be somewhat higher, because of the higher expenses associated with food consumed away from home.

It is rather difficult to say which approach is best, as each has its advantages. In input-output analysis a high degree of aggregation is unavoidable and most of the analysis is in dollar values. In this respect, Method I provides a useful approach to estimating final demands. It eliminates the necessity of price calculation for individual commodities. Price calculation and estimation could present a very difficult problem. Also, Method I is based on allocation theory, which is closely akin to input-output analysis and, as such, may have greater intuitive appeal than Method II. On the other hand, when the sectors in input-output analysis are highly disaggregated, Method II has the advantage over Method I in indicating changes in the consumption and expenditures in the disaggregated sectors. Other advantages of Method II over Method I are created by the high costs involved in estimating the linear expenditure model and the lack of data on expenditure surveys.

Total Expenditures for 1980

The analysis and the results of the two approaches were carried out in per capita terms. The total expenditures may be determined by a simple multiplication of the per capita expenditures by the projected level of population for 1980. A study of Canadian population projections, 1969 to 1984, by the Census Division of Statistics Canada, estimated the population for 1980 as being 25,210,300 persons.[1] This estimate was used in arriving at total expenditures (Table 7.4).

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[1] J.L. Pando, "The Pattern of Butter Consumption in Canada," Canadian Farm Economics, Vol. 5, No. 5 (December, 1970), p. 35.

Table 7.4

TOTAL EXPENDITURES ON MEAT AND DAIRY PRODUCTS, CANADA, 1980

Products	Expenditure	Products	Expenditure
	million dollars (1969)		
Method I			
Meat	3,748.02	Dairy Products	1,519.42
Method II			
Beef	1,783.88	Milk and Butter	683.96
Pork	860.37	Butter	270.00
Mutton and Lamb	52.19	Cheese	348.15
Veal	109.66	Concentrated Whole Milk Products	59.24
Poultry	756.31	Concentrated Milk Byproducts	154.29
All Meat	$3,699.81	All Dairy Products	$1,515.64

The total expenditure on meat for 1980 is expected to reach 3,748.02 million 1969 dollars, based on Method I. This total compares with 2,671.80 million dollars in 1969. The change in expenditure from 1969 to 1980 is thus expected to be 40.3 percent. The 1980 expenditure estimate on meat, based on Method II, was 3,699.81 million 1969 dollars, as compared with the based period expenditure of 2,482.67 million dollars -- a change of 49 percent.

In the case of dairy products, the estimated expenditure for 1980 was 1519.42 million dollars by Method I and 1515.64 million dollars by Method II. Using the two methods, the corresponding estimates for 1969 were 1,232.09 and 1,302.20, respectively. The estimated percentage change from 1969 to 1980 was 23.3 percent by Method I and 16.4 percent by Method II. Differences in the percentage change will be accounted for by the difference in the estimates of each method for the base period, 1969, and the target year, 1980.

CHAPTER VIII

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

Summary

This study was concerned with the analysis of Canadian demand for meat and dairy products and the projection of conditional estimates in dollar terms of the demand for these products in 1980. Trends in food expenditure and consumption in Canada in relation to six other categories of goods and services (clothing; housing; transportation and communication; health, recreation, education, and entertainment; and miscellaneous goods and services) were described and analyzed for the period 1949 to 1969. Especial emphasis was placed on the consumption and expenditure patterns for meat and dairy products for the same period. The changes in population, prices, and income for the period 1949 to 1969 were also discussed.

Econometric models were utilized in measuring the effects of prices and income on the per capita consumption and expenditure for the seven aggregated categories of goods and services and for meat and dairy products. The quantitative analysis and the projections made use of two methodological approaches. Method I involved the use of the linear expenditure system to estimate trends and relations respecting the allocation of consumers income among the seven competing commodities, including food as a group. The system was used in estimating the expenditure on food for 1980. Using the estimated expenditure on food and the results of an analysis of the budget proportions devoted to meat and dairy products, estimates of the per capita expenditure on these commodities

were made for 1980.

Method II used single equation regression analysis on individual commodities constituting the groups meat and dairy products to estimate price, income elasticities and trend. The resulting equations were used to project the 1980 consumption levels of these commodities. These levels were multiplied by their corresponding 1969 prices to estimate the total expenditure on these commodities. The results of the two methodological approaches were compared.

Conclusions

Several conclusions could be drawn from this study.

1. During the period of 1949-1969 there was a general increase in consumption expenditures on all categories of goods and services. However, the rates of increase were different. Food expenditure showed a declining proportion of consumers income, especially in the latter half of the period. Prices and income increased steadily during the period, but population increased at a declining rate.

2. The examination of the pattern of meat consumption indicated that beef and poultry consumption were increasing; pork and mutton consumption were highly variable; and there was a decline in the consumption of veal. The budget proportion devoted to meat was remarkably stable, averaging 25.9 percent for the selected survey years 1953 to 1969. Meat, however, accounted for about half of the expenditure on food consumed away from home which increased almost twofold during the period 1953 to 1969.

3. A similar examination of the pattern of dairy products consumption showed declines in the consumption of milk, butter and concen-

trated whole milk products with increases in the consumption of cheese and concentrated milk byproducts. The budget proportion for the dairy products declined for the period 1953 to 1969.

4. The hypothesized econometric models explained satisfactorily the trends in consumption and expenditure for the seven categories of goods and services and the individual commodities constituting meat and dairy products. Both methodological approaches gave reasonable estimates of demand expenditure for 1980. Assuming that the population will reach 25.2 million by 1980, the total expenditure on meat is expected to reach 3,748 million 1969 dollars based on Method I. This total compares with 2,672 million dollars in 1969 estimated by Method I. The 1980 expenditure estimate on meat, based on Method II, was 3,700 million 1969 dollars as compared with the base period estimate of 2,483 million dollars by this method.

In the case of dairy products, the estimated expenditure for 1980 was 1,519 million 1969 dollars by Method I and 1,516 million 1969 dollars by Method II. Using the two methods, the corresponding estimates for 1969 were 1,232 million and 1,302 million dollars, respectively.

Implications of the Study

1. Despite the theoretical limitations which constrain the use of ordinary least squares regression in demand analysis, the model could be relied on to give valuable estimates in projected demands for individual commodities. Although, theoretically, the prices of a host of other commodities are hypothesized as influencing the demand for a particular commodity, regression analysis showed that only a few of these prices generate an effect significantly different from zero. Therefore, in

forecasting, one should question the rationale of complicating a model unnecessarily with the inclusion of variables that do not significantly affect the dependent variable.

2. In demand analysis and projections relating to aggregates or commodity groups, the linear expenditure system provides a plausible approach to ascertaining consumer response to prices and income. When combined with cross-section data on expenditure proportions on various commodities, it becomes a useful technique in estimating future expenditure balances. Since the technique attempts to solve an allocation problem, that is, how the consumer allocates his expenditure income to various foods and services, the model could be modified to deal with specific commodity groups. Thus, given a series of expenditures on each class of meat and the corresponding prices, the model could be used to estimate direct price, cross-price, and income elasticities for the individual commodities within a single system. At present, data limitations preclude this approach, but the implication is that it would not be necessary to pursue a separate analysis on cross-section data in order to estimate budget proportions.

3. The two approaches provide reasonable and close estimates of consumption expenditures for 1980. Both approaches indicated an increase in meat expenditure and a relative stability in dairy expenditure. It was expected that the difference between the estimates would be greater due to the higher prices paid for food consumed away from home. The smaller difference could be due to over-estimation of consumption quantities through the regression models, or under-estimation of expenditures by the linear expenditure model.

4. Work in the study and related studies reveals the high volatility of the elasticity concept. This concept, based on the *ceteris paribus* assumption at a particular time, leads to widely differing estimates, especially when the models are specified differently. Researchers should thus utilize the estimates in relation to the model from which they came.

5. Several factors, which on theoretical grounds are believed to affect consumption and expenditure, are difficult to estimate when time-series data are involved. The use of cross-section surveys gives information concerning the nature of the interaction of such factors as urbanization, family characteristics, level of education, social customs, and the like. There appears to be a marked stability in the behavior pattern of consumers with respect to the consumption and expenditure on meat products over the period 1949 to 1969. However, the increasing trend in expenditure on food consumer away from home and the decreasing proportion of the food dollar devoted to home-consumed dairy products, clearly indicates a change in consumers' response over time. Trend analysis could play a major role in demand analysis and projections.

6. It is often argued that estimates of price and income elasticities from time-series data are inappropriate because of the high correlation existing between prices and income. It also has been suggested that this shortcoming could be eliminated by using cross-section data in estimating income elasticities, then incorporating these estimates in time-series analysis. Application of the linear expenditure system to individual commodity groups provides a unified method of dealing with this problem.

7. The study emphasized the national demand aspects of the problem. However, it is also necessary to obtain regional expenditure estimates for the sectors of the input-output model. While supply response considerations are important at the national level, they become even more crucial at the regional level. The unavailability of research work at both levels posed a grave problem. It is rather difficult, in the regression approach, to go beyond the assumption of a per capita consumption similar to that of the nation. In estimating expenditures, however, regional price differences may be taken into consideration. In the case of the linear expenditure approach, regional differences in budget proportions could be utilized.

Limitations of the Study

The most serious limiting factor in this study is the lack of appropriate data. To make an in-depth analysis of demand interrelationships, farm level, wholesale level, and retail level prices must be available. Comparative quantities at the various levels of the marketing chain must also be available. Consumer expenditures could be estimated from these, and attention given to marketing margins. Data should be readily available for individual commodities, as well as commodity groups. Only when the appropriate data are available could the researcher apply or test his models based on sound demand theory.

The techniques used are not without limitations. Using regression analysis precludes the inclusion of several variables which might affect consumption. The technique is applicable to specific conditions regarding the error terms and the nature of the relationships between the dependent and independent variables. The assumptions of the model

have been discussed. Demand relationships are not necessarily linear, with respect to a few included independent variables, and the resulting estimates could be biased and inconsistent when ordinary least squares procedures are applied.

The linear expenditure system may have contributed to solving the problems of inordinate bias and inconsistency, but the estimation procedures involve grave computational problems and the high costs encountered in generating estimates considerably limits its application. The assumption on which the linear expenditure system is based is restrictive in that: (a) the consumer is always assumed to buy a necessary basket of goods, (b) the proportions in which the remaining income is divided are fixed, and (c) the utility function from which the model is derived is of a specific form. The improvements suggested for the model have been discussed earlier.

In both cases the analyses were perforce static. In a dynamic world in which economic phenomena are in a state of flux, dynamic elements should be included in the models. The problems involved in incorporating dynamic elements in these models are legion and solutions are not imminent at this time. In any case, the gains derived from using models involving dynamic elements to provide projections for a static input-output model may be small compared to the time and cost.

Further Research Needs

This study has focused on the demand for meat and dairy products and has two approaches in the analysis and projections of demand expenditures. There are several areas in which the approaches leave much to be desired. The lack of data and analysis in certain areas, upon which the

approaches depend, come to the forefront.

Many more data need to be published concerning the prices and the quantities consumed of various commodities. More information from cross-section data and more rigorous analysis of such data are necessary. Few data concerning market margins, and even less on analysis of market margins, are available. Quality changes from time to time constitute an important aspect in demand analysis for all commodities. This area needs attention. Further research is needed to ascertain the effect of urbanization, regional differences, age and sex distribution, and such quantitative variables which play a role in determining consumer behavior.

With respect to the linear expenditure system much more work is needed in the field of model specification and estimating techniques. The available computer procedures are so costly at present that they limit extensive applications of the model.

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APPENDICES

APPENDIX A

THE SOUTH SASKATCHEWAN RIVER BASIN

The economic study area and hydrologic or watershed boundary of the South Saskatchewan River basin is shown in Figure A-1. The hydrologic and economic boundaries do not coincide because the latter was made to follow the census divisions to facilitate data collection. The hydrologic boundaries contain the watersheds of the Oldman and the Bow Rivers which are tributaries of the South Saskatchewan River. The economic study area boundary does include a part of the Milk River watershed.

The need for irrigation in the region arises out of the arid conditions which characterize the region and the high variability and uncertainty of the rainfall pattern. Annual precipitation varies from 12 to 14 inches in the eastern half of the area to 16 to 26 inches in the western portion. Crops have been grown under irrigation since 1919 in the Taber Irrigation District. However, in recent years there has been some concern about water shortages in the region and acid deterioration in the irrigation facilities threatens further reduction of water supply in the future.

FIGURE A-1

SOUTH SASKATCHEWAN RIVER BASIN STUDY

APPENDIX B

SOURCE OF DATA

Almost all the information used in this study was obtained from the Dominion Bureau of Statistics (now Statistics Canada). Some additional information was obtained through personal communication with experts in certain fields. For example, in order to arrive at the retail conversion factor for the carcass weight of beef, veal, mutton, and pork, help was sought from researchers in this field and from other people in the meat trade.

Data for the Linear Expenditure Model

The Dominion Bureau of Statistics has compiled data regarding personal expenditure on consumer goods and services in constant (1961) dollars and in current dollars for the 1926-1969 period. The data was categorized under eight broad aggregates. Two categories -- (a) gross rent, fuel and power, and (b) furniture, furnishing and household equipment, and operation -- were combined to constitute housing expenses. The components of the seven categories used in this study were as follows:

(1) Food
- Food and non-alcoholic beverages
- Alcoholic beverages
- Tobacco products and smokers' accessories

(2) Clothing
- Mens' and boys' clothing
- Womens' and childrens' clothing
- Footwear
- Other

(3) Housing
- Gross rents paid by tenants
- Gross imputed rents
- Other occupancy charges
- Electricity
- Gas and other fuel
- Furniture and household appliances
- Household furnishings, table and kitchen ware, and garden equipment
- Laundry and dry cleaning
- Other

(4) Transportation and Communication
- New and used automobiles
- Other personal transportation equipment
- Automotive operating expenses and purchased transportation
- Telephone and telegraph
- Other communication

(5) Recreation, Entertainment, and Education
- Recreation equipment and services, entertainment and cultural services
- Books, newspapers, and magazines
- Education

(6) Health
- Services of physicians and related practioners
- Hospital care and the like
- Drugs
- Other

(7) Miscellaneous
- Personal care and effects
- Expenditure in restaurants and hotels
- Financial, legal, and other securities
- Other foods
- Net expenditure aboard

The price indexes for the seven categories of goods and services were obtained by dividing the current dollar expenditures by the constant dollar amounts allocated to each category (Table B-1). Per capita consumption expenditures were obtained by dividing total expenditures by population.

Table B-1

PER CAPITA EXPENDITURE ON CONSUMER GOODS AND SERVICES, CANADA, 1949 TO 1969

Year	Food	Clothing	Housing	Transportation and Communication	Recreation Education and Entertainment	Health	Miscellaneous
				constant 1961 dollars			
1949	313.08	111.40	243.92	127.84	58.45	57.93	149.03
1950	324.97	110.12	253.50	143.60	60.02	60.82	155.63
1951	317.44	105.15	246.77	132.20	59.46	61.46	171.32
1952	323.26	111.07	263.43	143.58	63.84	62.94	186.25
1953	331.09	112.29	276.59	151.16	71.67	64.80	184.57
1954	331.58	110.03	285.54	145.22	72.55	67.05	194.61
1955	336.48	113.65	301.95	165.12	74.98	69.24	202.64
1956	350.04	119.02	315.59	173.59	72.07	74.62	214.10
1957	353.52	119.56	320.71	168.81	71.16	76.22	218.72
1958	350.53	120.73	327.87	173.59	71.37	80.74	214.81
1959	356.57	123.26	342.16	179.03	72.47	85.45	215.41
1960	360.83	125.46	345.61	178.85	72.80	90.32	219.41
1961	358.65	124.79	355.96	181.32	77.26	56.80	222.56
1962	363.45	126.57	365.66	194.59	82.39	56.72	224.67
1963	354.06	126.41	382.44	205.59	84.52	59.43	232.90
1964	369.56	128.41	400.26	220.16	90.62	61.38	252.26
1965	376.24	131.08	415.70	238.39	96.16	64.14	262.12
1966	377.37	131.15	434.22	242.52	99.52	66.30	286.23
1967	390.15	131.83	449.55	247.64	106.05	68.32	287.87
1968	386.91	133.63	463.07	256.51	108.32	73.42	306.50
1969	395.33	137.22	478.51	260.24	123.50	68.37	333.84

Source: Calculated from Statistics Canada, "Table 54, National Income Expenditure Accounts - 1926 to 1969" (unpublished).

Table B-2

PRICE INDEXES OF CONSUMER GOODS AND SERVICES, 1949 TO 1969 (1961 = 100)

Year	Food	Clothing	Housing	Transportation and Communication	Recreation Education and Entertainment	Health	Miscellaneous
1949	0.8249	0.7785	0.7659	0.7371	0.6539	0.6226	0.6612
1950	0.8418	0.8821	0.8119	0.7791	0.6707	0.6319	0.6903
1951	0.9548	0.9830	0.8912	0.8553	0.7215	0.6911	0.7683
1952	0.9516	0.9875	0.8989	0.8882	0.7671	0.7495	0.7895
1953	0.9152	0.9784	0.9204	0.8948	0.8167	0.7744	0.7982
1954	0.9114	0.9721	0.9356	0.9036	0.8449	0.8107	0.8229
1955	0.9118	0.9608	0.9475	0.8808	0.8700	0.8335	0.8387
1956	0.9202	0.9666	0.9598	0.9040	0.8792	0.8633	0.8676
1957	0.9518	0.9668	0.9773	0.9568	0.8959	0.9115	0.9015
1958	0.9821	0.9762	0.9904	0.9713	0.9532	0.9463	0.9335
1959	0.9857	0.9759	0.9990	0.9981	0.9732	0.9746	0.9514
1960	0.9912	0.9848	1.0008	0.0034	0.9869	0.9926	0.9738
1961	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1962	1.0188	1.0098	1.0052	1.0022	1.0144	1.0180	1.0399
1963	1.0422	1.0372	1.0090	1.0064	1.0338	1.0338	1.0569
1964	1.0543	1.0622	1.0136	1.0047	1.0635	1.0541	1.0812
1965	1.0842	1.0796	1.0222	1.0147	1.0948	1.0802	1.1290
1966	1.1385	1.1189	1.0391	1.0295	1.1446	1.1093	1.1766
1967	1.1486	1.1729	1.0733	1.0677	1.2186	1.1614	1.2263
1968	1.2067	1.2042	1.0108	1.1000	1.2710	1.1786	1.2876
1969	1.2430	1.2384	1.1597	1.1337	1.3672	1.2104	1.3374

Source: Calculated from Statistics Canada, "Tables 53 and 54, National Income and Expenditure Accounts, 1926 to 1969" (unpublished).

Data for Regression Analysis

The Dominion Bureau of Statistics has published time-series data on income, price and price indexes, and quantities of various products consumed on a per capita basis. Unfortunately, the quantity data for beef, veal, pork, mutton, and lamb represent carcass weights. This meant that, after the analysis and projections were made, it was necessary to convert carcass equivalents to retail equivalents.

The 1969 average retail price for each commodity was obtained by dividing the average per capita expenditure by the average quantity of all the commodities consumed per capita. The data was published by Statistics Canada in Catalog Number 62-531.

Family Food Expenditure Analysis

Information on family food expenditures are contained in a series of publications on family food expenditures for 1953, 1955, 1957, 1958 1962, and 1969. Though the survey used different approaches and differed in sampling coverage, the results seemed consistent and comparisons could be made without major adjustments in the data.

An attempt was made to obtain the best data possible, but there is no doubt that there are unavoidable inaccuracies in the data used in this study. The inaccuracies may have been magnified by attempts to convert data given in one form to another in order to meet the requirements of the study. Albeit, the situation demonstreates the unavoidable gap existing between demand theory and empirical analysis.

Table B-3

DISTRIBUTION OF THE FAMILY FOOD DOLLAR BETWEEN URBAN AND RURAL AREAS FOR CANADA AND THE PRAIRIE REGION, 1969

Product	Total Urban & Rural		Urban		Rural	
	Canada	Prairie	Canada	Prairie Region	Canada	Prairie Region
			percent			
Meat and Poultry	25.9	24.8	26.0	25.0	25.5	23.0
Dairy Products	13.4	13.5	13.2	13.3	14.4	14.2
Eggs	2.6	2.4	2.5	2.5	3.1	2.2
Bakery	10.5	10.1	10.0	9.5	13.0	12.3
Fish	1.7	1.6	1.7	1.6	1.8	1.7
Fats and Oils	1.7	1.9	1.6	1.7	2.4	2.5
Fruits and Vegetables	13.0	13.5	12.9	13.2	13.2	14.4
Frozen Foods	1.3	1.3	1.4	1.5	0.9	0.9
Other Foods	13.0	13.4	12.7	12.8	14.2	15.2
Food Away From Home	17.0	17.5	18.2	18.8	11.5	12.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Statistics Canada, DBS Daily (Thursday, December 31, 1970), p. 3.

Table B-4

PERCENTAGE OF THE FAMILY FOOD DOLLAR ALLOCATED TO SELECTED FOOD GROUPS, CANADA, 1953 TO 1969

Year	Meat and Poultry	Dairy Products	Food Away From Home
1953	25.3	15.6	9.9
1955	25.0	15.4	9.6
1957	26.0	15.7	11.7
1962	27.2	14.3	12.2
1969	25.9	13.4	17.0

Sources: Statistics Canada, Urban Family Food Expenditure 1953 to 1962, (Ottawa: Queen's Printer for Canada, 1953 to 1969); Statistics Canada, Family Food Expenditure 1969, (Ottawa: Queen's Printer 1971).

Table B-5

PATTERNS OF AVERAGE WEEKLY FOOD EXPENDITURE, BY FAMILY INCOME, IN SEVEN CITIES, CANADA, 1962

Commodities	$3,000 - 3,999	$4,000 - 4,999	$5,000 - 5,999	$6,000 - 6,999	$7,000 - 7,999	All Families
Meat and Poultry	30.2	27.4	27.1	25.6	25.9	27.3
Dairy Products	11.9	12.1	12.4	10.8	9.9	11.7
Bakery and Cereal	12.7	13.1	12.6	12.0	11.5	12.6
Fruits and Vegetables	14.8	14.5	14.5	14.1	14.0	14.4
Eggs	3.4	3.2	3.0	2.9	2.3	3.0
Food Away From Home	8.3	10.0	10.7	15.4	19.3	12.1

Source: Statistics Canada, Urban Family Expenditure 1962, Cat. no. 62-524 (Ottawa: Queen's Printer for Canada, 1963), p. 32.

Table B-6

INDUSTRY SELLING PRICE INDEXES FOR SELECTED MEATS,

CANADA, 1956 TO 1970

(1961 = 100)

Year	Beef	Veal	Pork	Lamb
1956	83.0	80.0	92.9	100.9
1957	83.8	83.7	109.0	104.9
1958	106.5	99.4	101.3	109.1
1959	111.2	103.6	92.5	102.7
1960	101.1	99.2	95.7	107.1
1961	100.0	100.0	100.0	100.0
1962	111.4	106.4	104.5	103.1
1963	105.8	109.1	100.3	111.3
1964	99.4	103.1	96.9	113.6
1965	99.9	102.5	112.6	127.9
1966	114.3	121.2	124.4	135.0
1967	123.4	131.5	110.6	136.1
1968	123.4	133.1	117.1	148.7
1969	136.0	150.5	138.3	166.1

Source: Statistics Canada, Industry Selling Price Indexes 1956 to 1968, Cat. no. 62-528 (Ottawa: Queen's Printer for Canada, 1969), p. 53.

APPENDIX C

BILL C - 176

Bill C - 176 is an Act respecting the establishment of a National Farm Products Marketing Council and national marketing agencies for farm products. This Act is called the Farm Products Marketing Agencies Act.

Under the provisions of this Act the Governor in Council appoints a National Farm Products Marketing Council consisting of not less than three and not more than nine members, at least fifty percent of whom shall be primary producers, and in such a manner as to provide for regional representation -- one-third from the four Western Provinces, one-third from the two Central Provinces and one-third from the four Atlantic Provinces.

The Council is charged with (a) advising the Minister of Agriculture on matters relating to the establishment and operations of agencies authorized under the Act; (b) reviewing the operations as set out in the Act; (c) working with the agencies in promoting more effective marketing of farm products in inter-provincial and export trade.

The duties of the Council should be carried out in consultation with provincial governments having an interest in the establishment or exercise of the powers of any one or more of the agencies under the act or with such body or bodies established by these governments to exercise powers similar to the Council with respect to intra-provincial trade in farm products.

Any agency authorized by the Act serves to promote efficient and competitive production and marketing of the products under its jurisdiction, while ensuring that the interests of producers and consumers of such products are satisfied.

APPENDIX D

THE LEONTIEF INPUT-OUTPUT SYSTEM

The overall input-output balance of the national economy with m industries is as follows:

$$X_i - \sum_{k-1}^{m} x_{ik} = Y_i \qquad i, k = 1, 2, \ldots, m , \tag{1}$$

The relation stipulates that the total output, X_i, of industry i, less the amount of i's product absorbed by industry k, is equal to Y_i the amount of i's product going to final demand. Each industry is characterized by a set of production coefficients such that

$$x_{ik} = a_{ik} X_k \qquad i, k = 1, 2, \ldots, m , \tag{2}$$

in which each a_{ik} denotes the amount of each particular input absorbed by that industry per unit of output its own output.

Substituting (2) in (1) yields

$$X_i - \sum_{k=1}^{m} a_{ik} X_k = Y_i \qquad i, k = 1, 2, \ldots, m . \tag{3}$$

This general system of m linear equalities in m unknowns may be solved for x_i if the final demands are known. Thus,

$$X_i = \sum_{k=1}^{m} A_{ik} Y_k \qquad i, k = 1, 2, \ldots, m . \tag{4}$$

Here, each of the constants, A_{ik}, depends on the input coefficients, a_{ik}, of the m industries. The solution suggests that by substituting

any given level of final demand, Y_i, the corresponding rate of output, X_i, or the commodity, i, could be determined.

In regional analysis the model may be employed subject to some notational changes.

$$\gamma X_i - \sum_{s=1}^{n} \sum_{j=1}^{m} \gamma s\, x_{ij} = \gamma Y_i \qquad i, j = 1, 2, \ldots, m \qquad (5)$$
$$\gamma, s = 1, 2, \ldots, n$$

In this formulation γX_i represents the total output, X_i, of industry i in region γ; $\gamma s x_{ij}$ represents the flow from the i^{th} industry in region γ to the j^{th} industry in region s; γY_i denotes the final demand for the product of the i^{th} industry in region γ. The technical coefficients are given as:

$$\frac{\gamma_s x_{ij}}{{}_s x_j} = \gamma_s a_{ij} \,,$$

relating the flow of inputs from industry i, in region γ, to industry j, in region s, as some proportion of total production, x_j, of good j in region s.

The input-output model is based on the following assumptions:

1. The supply of each commodity or commodity group is unique to a single production sector. Aggregation of multi-product plants into a single sector violates this assumption.

2. The inputs required by any sector are dependent only on the level of output of that sector. This assumption implies constant returns to scale.

3. Production processes are additive. The different activities neither reinforce nor interfere with each other, thus precluding external economics or diseconomies of scale.